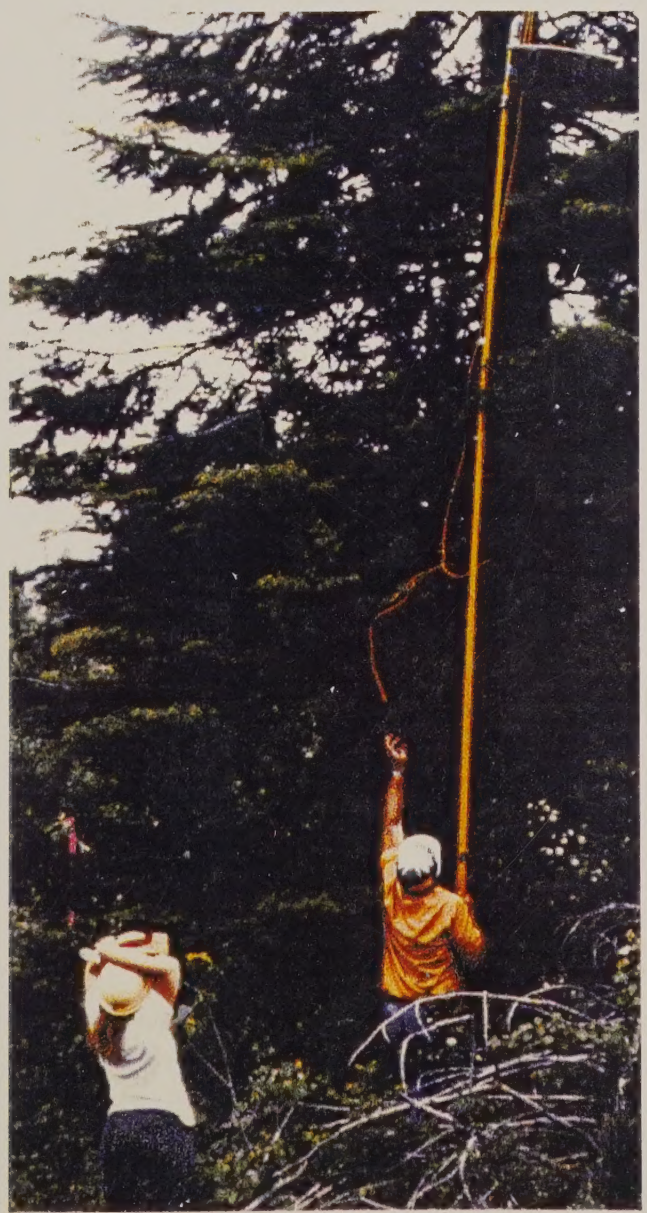
Forest Service

National Steering Committee for Management of Seed, Cone, and Regeneration Insects

Seventh Report

Forest Health
Technology
Enterprise
Team—Davis

2121C
Second Street
Davis, CA
95616



FHTET 96-07
March 1996

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Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

FHTET 96-07
March 1996

Seventh Report

National Steering
Committee for Management
of Seed, Cone, and
Regeneration Insects

Prepared for the Committee by:

John W. Barry
Chairperson

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CONTENTS

Bill Sery

Dave Rising

John Steward

Donna DeBarr

Gary DeBarr

Jack Barry

Chuck Masters

Carol Barber

Nancy Lorimer

Larry Barber

Jed Dewey

Alex Mangini

Roger Sandquist

Sandy Kegley

Darrell Ross

I. INTRODUCTION

A. Place and Purpose of Meeting

The 1995 meeting of the National Steering Committee for Management of Seed, Cone, and Regeneration Insects met at Coeur d'Alene, ID, 10-13 July 1995. The meeting was hosted by Sandy Kegley, R-1. Thanks to Sandy for the local arrangements, excellent facilities and an informative field trip. The meeting call letter and agenda are in Appendix A. The committee spent one and half day in meetings and one half day visiting regeneration sites and wild stands. The purpose of the meeting was to identify FPM technology development needs, to share information and to discuss the committee's future.

B. Attendees

Larry Barber	R-8/FH (Asheville, NC)
Gary DeBarr	SE Station (Athens, GA)
Jed Dewey	R-1/FHP (Missoula, MT)
Sandy Kegley	R-1/FHP (Coeur d'Alene, ID)
Nancy Lorimer	FHP-WO (Washington,DC)
Alex Mangini	R-8/FH (Pineville, LA)
Chuck Masters	Weyerhaeuser Co. (Centralia, WA)
Dave Overhulser	Dept. of Forestry (Salem, OR)
Bill Randall	R-6 (Corvallis, OR)
Dave Rising	MTDC (Missoula, MT)
Darrell Ross	OSU (Corvallis, OR)
Roger Sandquist	R-6/FH (Portland, OR)
Bill Sery	Oconto River Seed Orchard (White Lake, WI)
John Stein	PSW Res Station (Albany, CA)
John Steward	MTDC (Missoula, MT)
John Taylor	R-8/FH (Atlanta, GA)
Keith Windell	MTDC (Missoula, MT)
Jack Barry, Chairperson	FHTET (Davis, CA)

C. Committee Member and Other Reports

Please see individual reports and contributions included in Appendix B. Also included are MTDC progress reports on single tree spray systems and thermal control of insects in seed orchards.

II. DISCUSSIONS

A. Strategic Planning Sub-committee Report

This issue was not discussed substantially and the sub-committee report is included as Appendix E. There is no current effort to update the committee's 5-Year Plan based upon these recommendations. This topic was deferred to the 1996 meeting.

B. 1995 Technology Development Recommendations

The technology needs listed below were identified by the committee with number 1 being the highest priority.

1. Conduct pilot tests of synthetic nicotines, (Admire, Merit, and Gaucho), in seed orchards and plantations.

2. Develop a risk-rating system for western pine shoot borer in lodgepole pine and ponderosa pine.

3. Demonstrate and evaluate the "trap-out" potential of pheromone-based mass-trapping of cone beetles in eastern white pine and seed orchards.

4. Pursue single tree spray systems by evaluating reduction of volume, increasing tree coverage, and improving efficacy of application in orchards and wild stands.

See Appendix C for the 1994 and 1995 technology needs letter.

C. Role of Forest Service in seed orchard pest management was briefly discussed.

The paper The Role of the USDA Forest Service in Seed Orchard Pest Management Research and Development and associated correspondence are included as Appendix D.

D. Committee Member Issues and Comments from the Floor

- The committee feels it serves an important national function and that it should continue with or without formal WO or FHTET sponsorship.
- The committee feels that it should continue as a working group.
- Committee has questions on how it will interact with the FHTET.
- The committee serves the purpose of a way to interact with colleagues, share information, build partnerships, and exchange ideas. It is an important and valued forum.
- There is a general consensus that FS is under supporting seed, cone, regeneration insect work in the West. Committee sees need for more emphasis on regeneration insects problems.
- The committee needs to be better utilized by FHP and other FS staffs concerned with regeneration. The committee believes that the national steering committees are one thing that FHP does right.
- Committee should be used to review and rank TDP proposals.
- Director, FHP should consider dedicated/set aside dollars for minor use pests.
- Jack Barry will discuss these issues and comments with FHTET leadership.

E. Selection of Committee Chair.

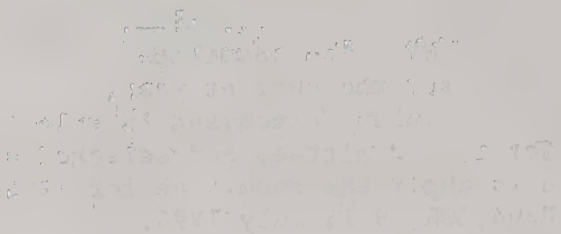
Jack Barry decided to step down as committee chair, having served this role since inception of the committee in 1988. The chair asked for a volunteer to chair the committee but none stepped forward. Jed Dewey suggested that the chair rotate annually with the current chair hosting the meeting. The committee endorsed Jed's idea and Roger Sandquist volunteered on this arrangement.

F. Next Meeting

The next meeting will be held at Bend, OR, July 9-11, 1996, Red Lion North Motel, hosted by Roger Sandquist, R-6.

III. SUMMARY

The National Steering Committee for Management of Seed, Cone, and Regeneration Insects met at Coeur d'Alene, ID, July 10-13, 1995, hosted by Sandy Kegley, entomologist R-1, Missoula, MT. The committee identified FPM technology development needs for the current year, discussed changes to the committee's tactical plan, discussed FS role in regeneration insects and future needs for the committee, and selected a new chair. Roger Sandquist volunteered to chair the committee for 1996 and to host the next meeting to be at Bend, OR, 9-11 July 1996.



APPENDICES

A. Meeting Call Letter and Agenda

B. Member Reports

C. Letter to Dir, FPM - Committee's 1994 and 1995 Technology Development Recommendations

D. White Paper - "The Role of the Forest Service in Seed Orchard Pest Management Research"

E. Sub-committee Report and Suggested Changes to 5-Year Plan

Appendix A

Meeting Call Letter and Agenda

United States Department of Agriculture
Forest Service
Washington Office
2121 C Second Street
Davis, CA 95616
PH (916) 757-8341
FAX (916) 757-8383

File Code: 3400

Date: April 19, 1995

First and Final Meeting Call Letter

National Steering Committee for Management of Seed, Cone, and Regeneration Insects

Dear Colleague:

The next meeting of the National Steering Committee for Management of Seed. Cone, and Regeneration Insects will be held July 10-13, 1995, at Coeur d'Alene, Idaho, accented by a field trip. Sandy Kegley is hosting the meeting and has organized the informative and inclusive field trip to view seed, cone and regeneration insect and disease problems in the upper plateau region.

The purpose of the meeting is to identify the five highest priority seed, cone, and regeneration insect problems as identified in the tactical plan, and submit them to the Director, FPM. The primary focus of the meeting, however, will be to decide the future of the committee. The enclosed draft agenda suggests specific topics. Please forward your agenda additions or other changes. For your review before the meeting I have enclosed a copy of the Southern Forest Tree Improvement Committee's position paper "The Role of the Forest Service in Seed Orchard Pest Management Research."

A block of rooms has been reserved at the Shilo Inn in Coeur d'Alene for evenings of July 10-11 and 13. The rate, which includes tax, is $64.74/single and $77.58/double. The per diem rate for Coeur d'Alene is $65.00 for lodging and $26.00 for meals and incidental expenses. Reservations must be made by calling (208)-664-2300 or (800)222-2244 before June 10, 1995 to receive the guaranteed rate. When making your reservation reference "National Cone & Seed Steering Committee." The Shilo offers a free continental breakfast, indoor pool, spa, sauna, steam room, and fitness center.

Flights are available into Spokane, WA, located about a 45 minute drive from Coeur d'Alene. The Shilo Inn provides shuttle service to and from the airport for $15.00 one way, but reservations need to be made ahead of time.

We have an opportunity for a dinner cruise on Lake Coeur d'Alene on Monday evening (only available on Monday) starting at 7:00 pm. The cost is $24.75. You will need to make reservations for the cruise by calling Sandy Kegley at (208)765-7355, fax (208)765-7307. I look forward to meeting with you at Coeur d'Alene, and have invited Ladd Livingston and colleagues from the Missoula Technology and Development Center to participate in the meeting. Please forward your suggestion on agenda items or invitees.

Sincerely,

John W. Barry

JOHN W. BARRY
Chair

Encls.

cc: M. Weiss
N. Lorimer
B. White
B. Eav
A. Bullard
L. Livingston
H. Thistle

DRAFT AGENDA

National Steering Committee for Management of
Seed, Cone, and Regeneration Insects

Shilo Inn
Coeur d'Alene, ID
July 10-13, 1995

		Discussant Leader
July 10, 1995	**Monday**	
1900	Dinner Cruise on Lake Coeur d'Alene (Optional) Call Sandy to make reservations	Sandy Kegley
July 11, 1995	**Tuesday**	
0830	Introduction	Jack Barry
	Schedule	
	Purpose of Meeting	
	Expectations	
0900	Washington Office Update - FPM Technology Development Program Pheromone Registration	Nancy Lorimer
0945	Review notes of Rhinelander meeting and 1994 recommendations	
1000	Strategic planning sub-committee report	Roger Sandquist
1015	White Paper - "The Role of the Forest Service in Seed Orchard Pest Management Research" - lost leadership or a renewed opportunity?	Chuck Masters
1130	LUNCH	
1300	Member reports beginning with Keith Windell and Bill Sery, Larry Barber, Dave Rising,	Members
1700	Adjourn to Social Committees' evening program	

July 12, 1995 Wednesday		Activity Leader
0800	Field Trip briefing - what, when, where, why, how	Sandy Kegley
0815	Priority needs FY 96	Jack Barry
0900	Future role of committee - is there a need, if so what?	

Develop a paper that answers the following:

- Who is the committee's sponsor?
- Self directed? Empowered by whom?
- Membership?
- Project management?
- Funding and entrepreneurship?
- Partnerships?
  - Industry
  - States
  - Academia
  - Inter staff/interdisciplinary
- New charter?
- Select new committee chair
- What next?

1130	LUNCH	
1300	Continue discussions	
1445	Next meeting - hosted by someone other than Forest Service?	
1500	Depart for **FIELD TRIP**	Sandy Kegley
!700	Arrive USDA Forest Service Priest River Experimental Forest	

Lodging in their guest cabins

Evening BBQ - with fireside storytelling led by **Larry Barber** featuring bucket truck and Chief Withlacoochee stories). "...without stories there is no tribe." David Guterson.

July 13, 1995 Thursday

0800 Depart Priest River Experimental Forest for various field stops on our way back to Coeur d'Alene.

Gisborne Mtn. We will have the opportunity to look at wild whitebark pine and examine the cones. There we will discuss the whitebark pine cone and seed insect project and the blister rust genetic resistance work conducted by Ray Hoff. Then we will head back towards Coeur d'Alene with two stops.

Lone Mtn. Tree Improvement Area. Discuss the long term growth trials for ponderosa pine and lodgepole pine, and the western white pine seed orchard. See terminal weevil, gouty pitch midge, and western pine shoot borer problems.

Coeur d'Alene white pine seed orchard. Demonstration of the individual tree sprinkler system and tour the nursery if time permits.

1700 - 1800 Arrive at Shilo Inn.

Appendix B

Member Reports / Papers

Larry R. Barber, R-8

Jack Barry, FHTET

Gary DeBarr, SE Station

Sandy Kegley, R-1/FHP
Ray Hoff

Bill Kilroy, MTDC

Dave Rising, MTDC

Bill Sery, R-9

Keith Windell, MTDC

Larry R. Barber, R-8

Acorn Survival
Asana Study

Northern Red Oak Flower to Acorn Survival Increases Following Monthly Applications of Asana® XL

L. R. Barber[1], D. T. Barrett[2], and C. K. Proffitt[3]

Abstract. Many insect pests attack northern red oak flowers, acornets, and acorns. Selected trees on the USDA Forest Service, Watauga Northern Red Oak Seed Orchard near Elizabethton, TN were treated monthly during the 1993 and 1994 growing season with Asana XL. At harvest in the fall of 1994, 34 percent of the 1993 flower crop survived to harvest on the Asana® XL treated trees, as compared to 18 percent on comparable unsprayed trees.

Keywords: Northern red oak, *Quercus rubra L.*; filbertworm, *Cydia latiferreana* (Walsingham); acorn weevil, *Curculio, Conotrachelus, Callirhytis* spp., treehoppers, *Platycotis vitata* (F.); seed orchard, Asana® XL, esfenvalerate.

Introduction

Genetically superior pine seed orchards routinely produce improved seed to assist the timber industry in reforesting harvested land. Without the array of first and second generation orchards, reforestation would be based upon seedlings from seed trees or wild seed collections resulting in low genetic quality. Foresters are aware of the need for high quality, fast growing hardwood seedlings for reforestation but in most cases the seedlings that are available are of unknown origin.

The Forest Service maintains and operates the 17 acre Watauga Northern Red Oak Seed Orchard near Elizabethton, TN. The orchard was planted in 1973 as a progeny test by the Tennessee Valley Authority. The study was thinned in 1987-8 to become a USDA Forest Service seed orchard on the Cherokee National Forest in 1984 and the first large seed crops were documented in 1989. In 1993, the orchard yielded enough acorns to supply the entire southern appalachian area with high quality northern red oak seedlings for reforestation.

Larry Barber, Entomologist, USDA FS (unpublished data) tagged and followed to maturity the 1989 and 1990 flower crops on selected trees in the Watauga Northern Red Oak Orchard. Only 3.8 percent of the 1989 flower crop remained healthy at harvest some 18 months later while the 1990 flower crop faired better with 27 percent healthy at harvest. No insecticides were applied to either of these flower crops.

Previous literature indicates that acorn weevils of the genus *Curculio* cause the most insect damage to oak acorns (Gibson 1982). These weevils and others in the genus

[1] Entomologist, USDA Forest Service, R 8, Forest Health, Asheville, NC
[2] Biological Technician, USDA Forest Service, R 8, Forest Health, Asheville, NC
[3] Seed Orchard Manager, USDA Forest Service, Cherokee National Forest, Elizabethton, TN

Conotrachelus, as well as the filbertworm *Cydia latiferreana* (Walshingham), can destroy a majority of the acorn crop (Solomon et. al. 1987). Both the pip gall produced by *Callirhytis operator* (O.S.) and the stone gall *Callirhytis fructuosa* Weld kill the acorn by either causing the nut to fall prematurely (pip gall) or by the stone gall replacing the seed. Tree hoppers, *Platycotis vittata* (F.), are potentially capable of damaging red oak flowers (Bob Ceich personel communication).

Little work has been done to control insect pests of oak seed crops (Kearby et al. 1986). Previous work, using both trunk implants and granular systemic insecticides showed a reduction in infestation levels but the insecticides may have also caused an increase in the percentage of desiccated acorns (Dorsey et al. 1962 and Dorsey 1967). Trunk implantation of the systemic insecticides phorate and Bidrin® yielded more sound acorns than granular applications of disulfoton and phosphamidon applied to the soil. In 1993, a study was initiated to investigate the effects of insect control measures on acorn production.

Material and Methods

In March 1993, 20 pairs of trees representing 17 families were selected for the study. A family consisted of half-sibling trees upon which acorn production with and without control spraying was assessed. One half of the trees received an insecticide treatment of esfenvalerate, Asana® XL, while the other half remained untreated. The treated trees were sprayed monthly throughout the summers of 1993 and 1994, with applications beginning in March. The Asana® XL solution was mixed at a rate of 9.6 fluid ounces in 100 gallons water. The application rate per tree varied during the season from approximately 2 gallons per tree in the early spring to nearly 10 gallons in the summer. The variation in application rates between spring and summer was because in the spring it took less spray solution to achieve proper coverage of the foliage and branches than in the summer when leaf production was at its peak. All applications were with an FMC DM020 high volume hydraulic sprayer set to apply the spray solution at 350 psi. The trees ranged in height from approximately 30 to 40 feet.

In May 1993, 20 branches on each tree were selected and tagged. Healthy pistillate flower structures were counted and recorded on data sheets at the first inventory. The branches and their developing acorns were revisited seven more times before harvest in November 1994, and the condition of their health was recorded.

In late August 1994, the final inventory was conducted, each tag was visited and the health of each acorn determined from visual observation. All acorns that were determined to be healthy were painted with one drop of fingernail polish and left attached to the tree. Nets were placed under each tree to catch the acorns when they dropped. Acorn collection began the first week of September and continued until November 2, 1995. During this acorn collection period, the nets were visited and the acorns collected three times each week. The painted acorns were separated from the rest of the acorns and placed into plastic bags and put into cold storage for later observation and dissection.

RESULTS AND DISCUSSION

Analysis of the 1993 flower crop survival from May 1993 to August 1994 indicated a significant difference at the one percent level in acorn production between treated and untreated trees. There was a significant family x treatment interaction, indicating that healthy acorn production in some families was not predicated upon the control measure. Thirty four percent of the flower crop survived to August 1994 on trees treated with Asana XL as compared to 18 percent on untreated trees. Both treated and untreated trees showed a dramatic decrease in healthy flowers at the second inventory (Figure 1). After this time, little difference or change in the percent healthy spread between treated and untreated trees was detected until the emergence and attack of acorn weevils in early August 1994.

Identifiable insect damage was observed only in the second year of acorn development and this was due primarily to pip gall, filbertworm, and acorn weevil attacks. Applying the results of the acorn dissections to the crop remaining in late August, we estimate that 28 percent of the original flower crop on treated trees would produce healthy acorns as compared to 7 percent on unsprayed trees (Figure 1).

Dr. Gerome Grant (personel communication) reported that several species of thrips were identified from the orchard as potential damaging agents to the newly formed flower and acornets. If thrips and treehoppers cause damage to oak flowers in the first year of the flower

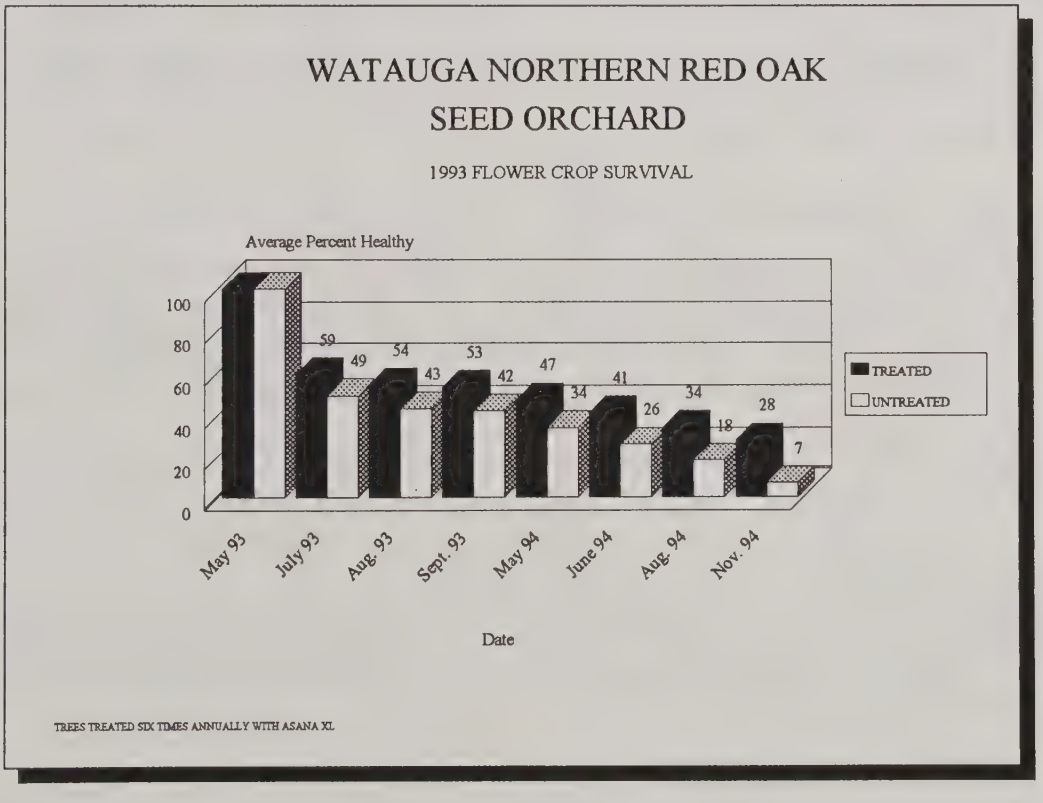


Figure 1. 1993 Watauga northern red oak seed orchard flower crop survival.

development cycle their control would explain the differences between treated and untreated flowers. Asana® XL is a broad spectrum insecticide and capable of controlling both pest groups. Neither potential pest was observed on the inventory trees during this evaluation.

In some families, more than two trees were used. There were six trees from family 915 (Appendix 1) and they responded similarly throughout the study and on average only 1 percent of the nuts were believed to be healthy at final harvest on untreated trees as compared to 29 percent on treated trees. In family 735, four trees were used and the untreated trees had more healthy acorns during the majority of the year, however, significant damage was detected at dissection. These dissections determined that many of the acorns were not healthy on the untreated trees and thus in the over-all rating for this family there were more healthy acorns on treated trees (Appendix 1). Family 323 was also represented by four trees and generally more healthy acorns were found on treated trees. In the remaining families, there were only one treated and one untreated tree. Generally for each pair of trees, more healthy acorns were present after harvest and dissection on the treated trees as compared to the untreated trees (Appendix 2). Only in family 565 were there more apparently healthy acorns at harvest in the untreated tree than on the treated tree. This may indicate genetic differences amoung the families in resistance to insect attacks. Family 526 showed the greatest treatment effect. The treated tree had 47 percent healthy acorns as compared to 2 percent on an untreated tree (Appendix 2). Comparative trees in families 526, 550, 903, and 913 also showed large differences in percent of healthy acorns between treated and untreated trees.

Wildlife such as deer, turkey, groundhogs, and squirrels are often observed in the fall and predation is usually not a problem. However, in 1994 deer were often observed leaving the orchard in the early morning and were assumed to be responsible for partially consumed acorns observed on the nets. Recovery of painted acorns was a problem in some trees. The percent recovery of painted inventory acorns ranged from 95 to 11 on the inventory trees (Figure 2).

At harvest, acorn weevils accounted for 37 percent damage on untreated trees as compared to 0.2 percent on treated trees. Filbertworm damage was less than one percent throughout the season including harvested acorns. Both pip gall and stone gall damage was observed at harvest. Losses from pip gall did not show up in our inventory data during August 1994 but were observed in the field. Losses from these two pests were less than one percent.

When dissected, some acorns appeared to be discolored and were categorized as being damaged by an unknown agent. This unknown damage category amounted to 25 percent of the acorns in the untreated trees and 16 percent in treated trees. This damage is characterized as having the appearance of potato rot and could be attributed to insects, such as acorn weevils, feeding in the tissue and introducing fungi or bacteria. In the untreated trees, this damage was found most frequently in acorns with insect damage. On the treated trees, however, it was found in acorns with no evidence of insect activity.

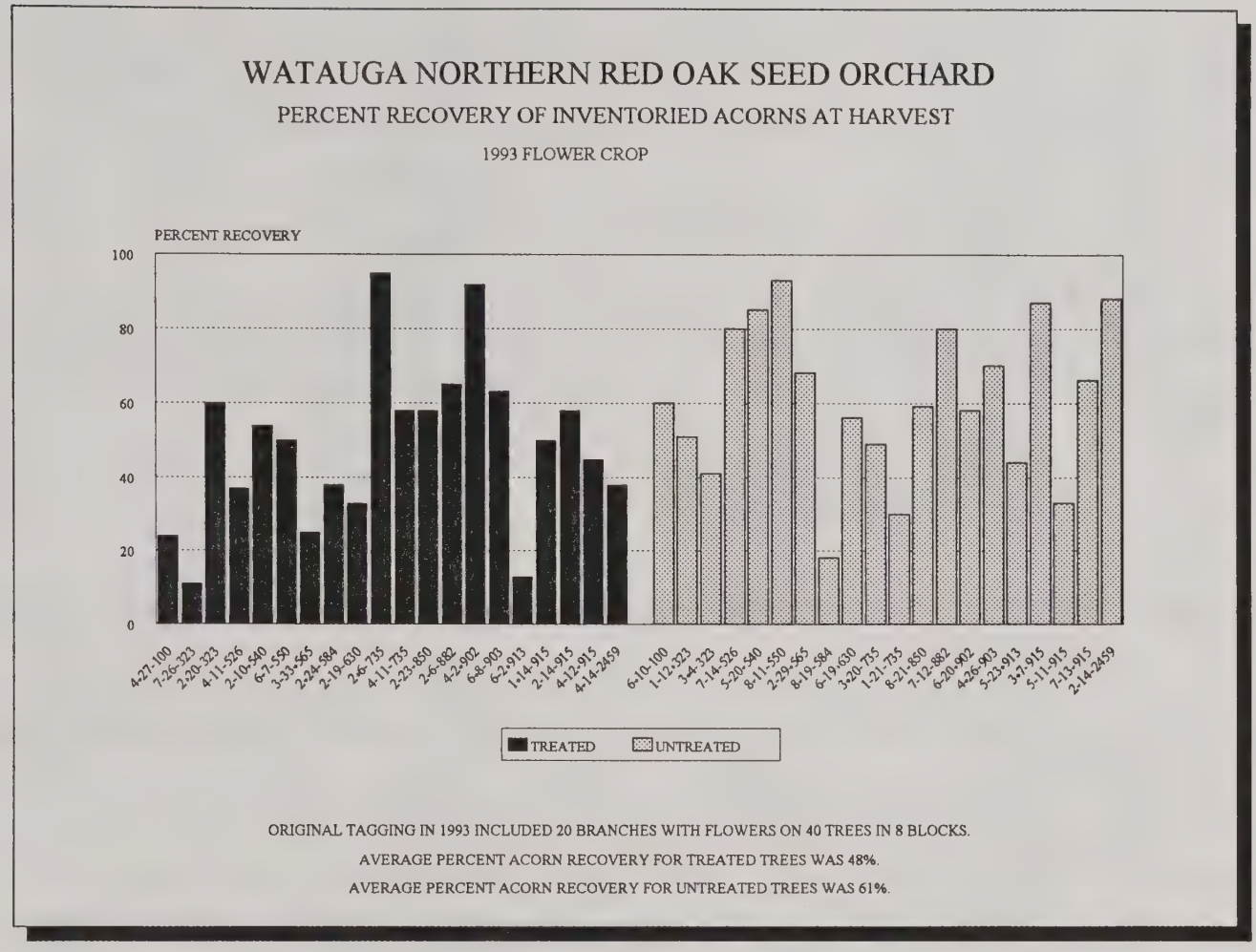


Figure 2. Percent recovery of inventoried acorns at harvest during the fall of 1994.

CONCLUSIONS

Monthly applications of Asana® XL, a synthetic pyrethroid insecticide, increased flower to acorn survival and produced more apparently healthy acorns on treated trees than on similar untreated trees. There appear to be two distinct time periods in the development of red oak acorns when insecticides are especially beneficial in increasing flower to acorn survival. These periods are in the early spring of the first year and in the late summer or fall of the second year.

Disclaimer

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Caution: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

ACKNOWLEDGMENTS

The authors sincerely thank Dr. Scott Schlarbaum, of the University of Tennessee for his assistance and guidance in the statistical analysis contained in this paper. Mark Remaley, graduate research assistant at the University of Tennessee is also thanked for his assistance in the statistical analysis.

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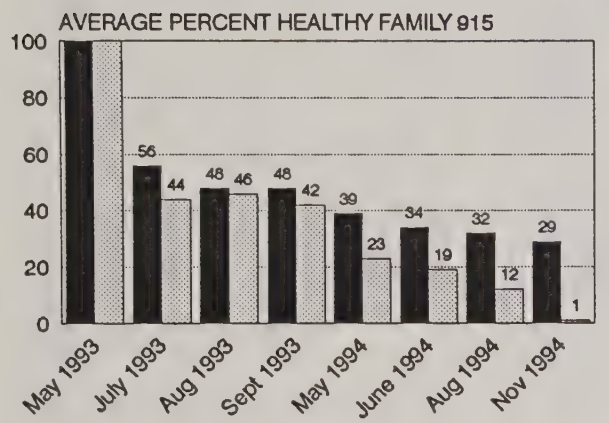
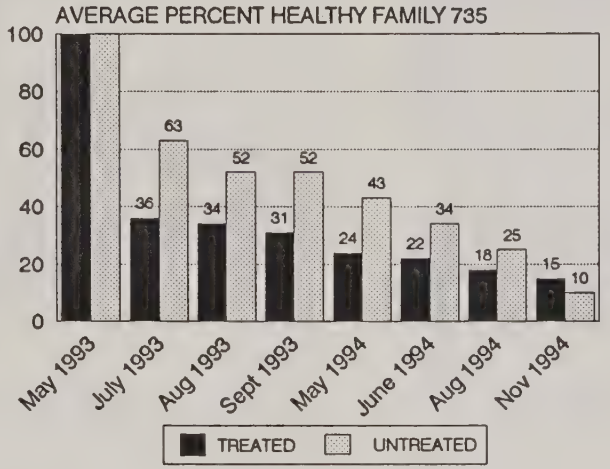
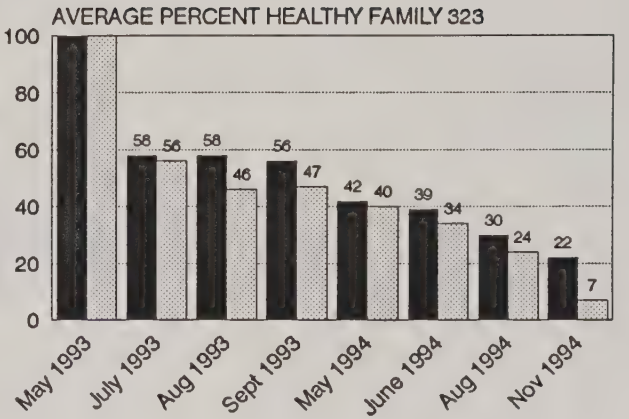
WATAUGA NORTHERN RED OAK SEED ORCHARD

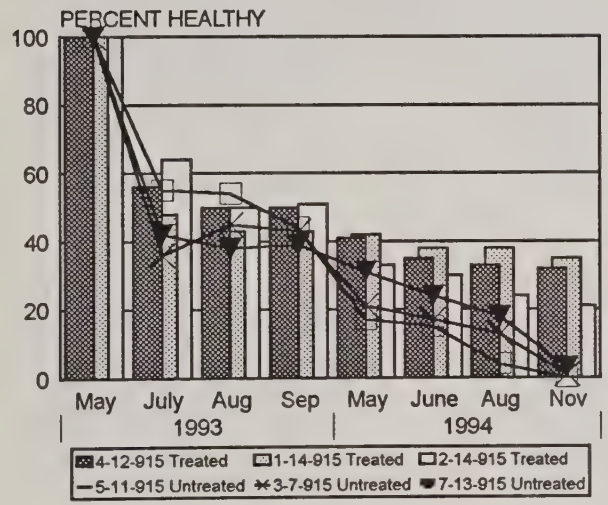
FAMILIES 915, 735, & 323 TREATED VS UNTREATED

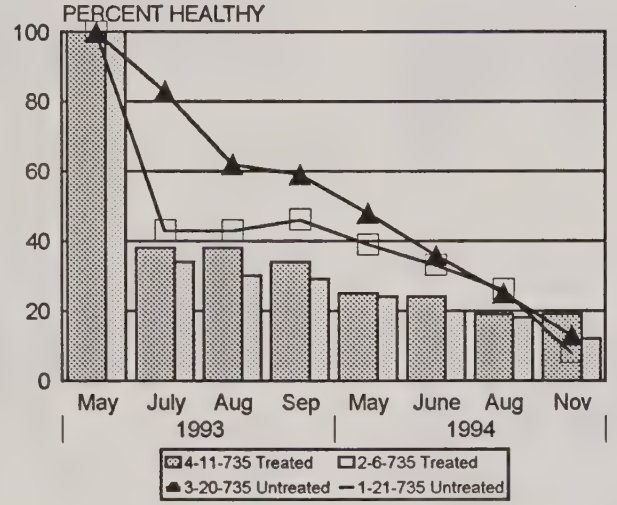
1993 FLOWER CROP SURVIVAL

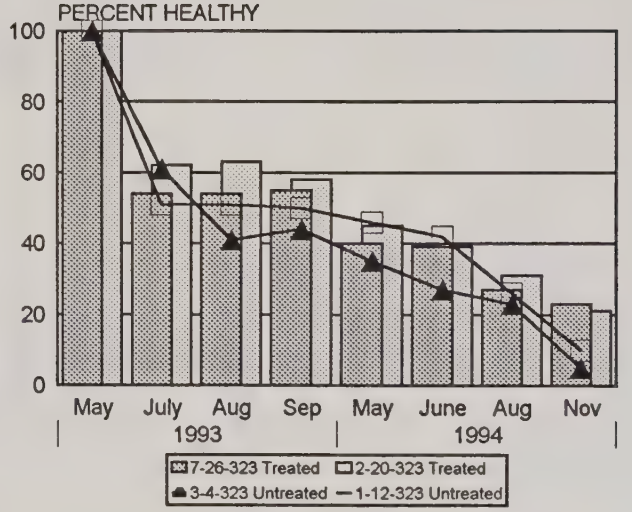










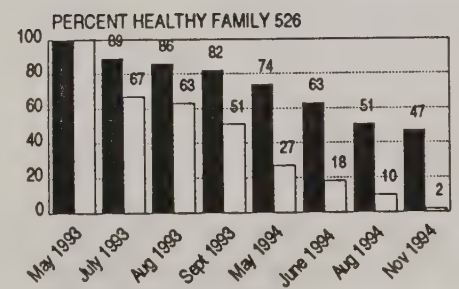


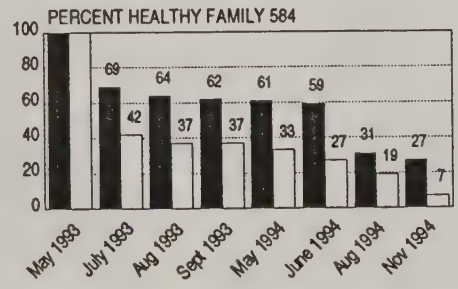
ORIGINAL TAGGING IN 1993 INCLUDED 20 BRANCHES WITH FLOWERS PER TREE.
THREE TREES TREATED MONTHLY WITH ASANA XL 1993 THRU 1994, THREE TREES UNTREATED
NOVEMBER 1994 ALL REMAINING TAGGED ACORNS WERE HARVESTED AND DISSECTED TO DETERMINE HEALTH

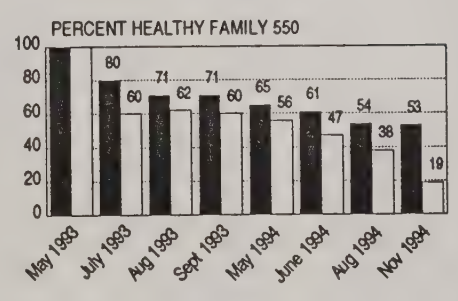
APPENDIX 1

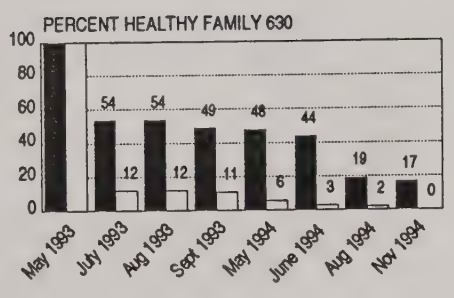
WATAUGA NORTHERN RED OAK SEED ORCHARD

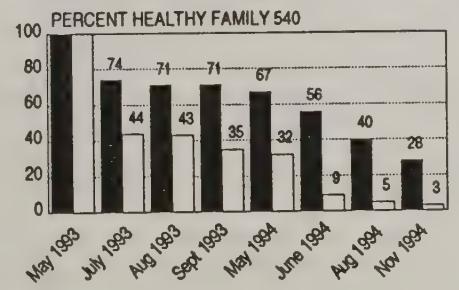
FAMILY COMPARISONS OF TREATED AND UNTREATED TREES

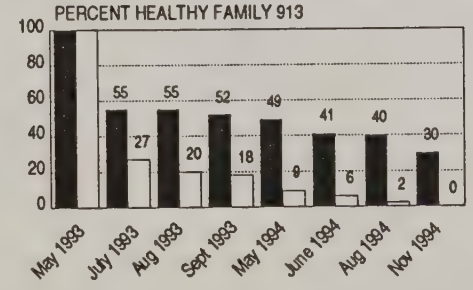


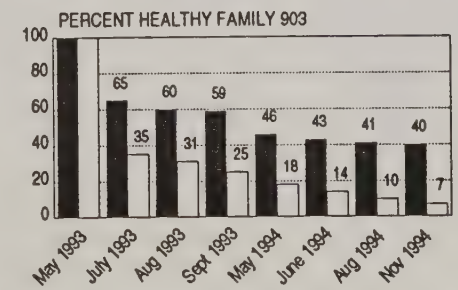


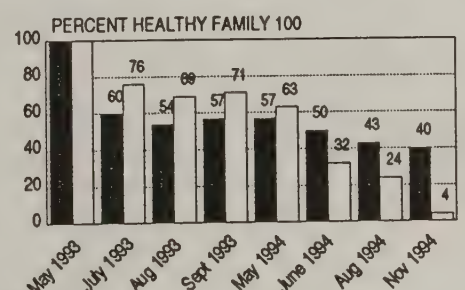


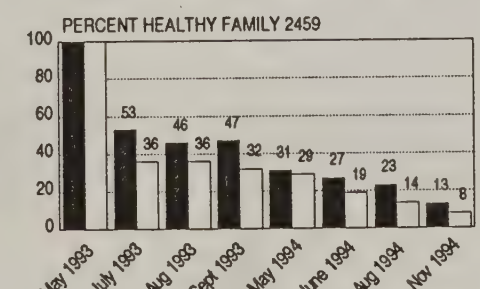


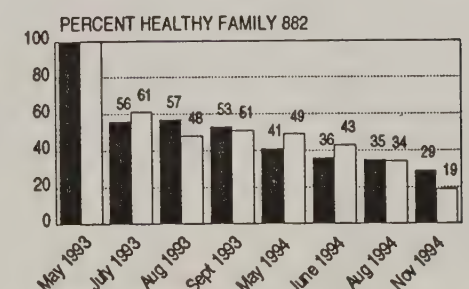


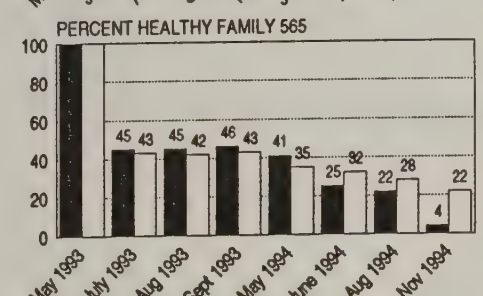


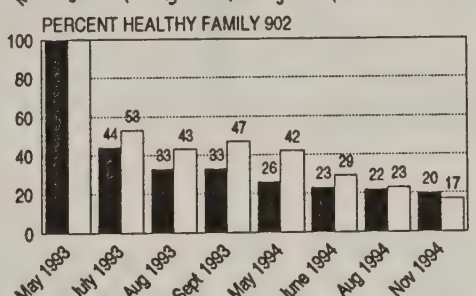


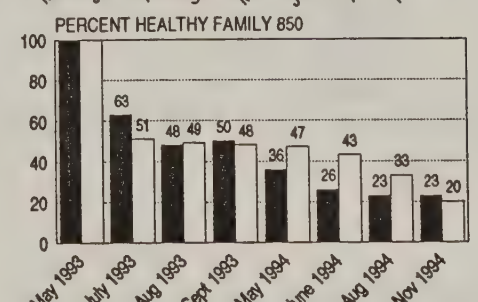












TWENTY BRANCHES WITH FLOWERS WERE TAGGED IN MAY 1993.
TREATED TREES WERE TREATED MONTHLY WITH ASANA XL 1993 THRU 1994.
NOVEMBER 1994 ALL REMAINING TAGGED ACORNS WERE HARVESTED AND DISSECTED TO DETERMINE HEALTH

APPENDIX 2

Jack Barry, FHTET

Biorational Book
Blue Oak Seeding Survival
Canadian IPM for Seed
Orchards

NEW from ACS

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Title	**Biorational Pest Control Agents: Formulation and Delivery**
Edited by	Franklin R. Hall, *Ohio State University* John W. Barry, *Forest Service, U.S. Department of Agriculture*
Series	**ACS Symposium Series No. 595.** Developed from a symposium sponsored by the Division of Agrochemicals at the 207th National Meeting of the American Chemical Society, San Diego, California, March 13-17, 1994.
Audience	Entomologists; Agricultural Engineers, Microbiologists, and Extensionists; Pesticide Manufactures.
Level	Graduate and professional
Scope	A multi-discipline focus on new and emerging pest control technology; identifies critical needs of formulation and novel delivery systems for the baculoviruses, bacteria, fungi, phermones, hormones, and nematodes being advocated for agricultural and forest pest management strategies of the 90's. Provides a reference for biorational agents currently used to control agricultural and forestry pests. Addresses the registration/data requirements and basic information necessary for registering environmental pest control agents.
Contents	Please see the contents listing on the reverse of this page.
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Other Information	**U.S. & Export, $84.95** **ISBN 0-8412-3226-1** **LC 95-13986** **Clothbound, 320 pages** **Illustrated, 6 by 9 inches**
PACT	All titles (PA 400), Agricultural/Agrochemicals Chemistry (PA 402), Biological Chemistry (PA 403), Environmental/Health Chemistry (PA 408), Biotechnology (PA 419), Toxicology (PA 421), Chemical Information (PA 423)
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Contents

Many blue oaks in the South Sierra Range region are growing under difficult conditions, including rocky coarse soils.

Planted blue oaks may need help to survive in Southern Sierras

Theodore E. Adams ❑ Neil K. McDougald

Competition from annual herbaceous plants is one of many factors inhibiting establishment of blue oaks in California. Other factors include drought and large and small mammal depredation; gophers are a particularly serious threat to the seedling's emergence and survival. To measure the impact of these and other factors, a series of studies compared the emergence and survival of directly seeded acorns and 2-month-old nursery stock. Results show that careful site selection, control of competition, and protection from mammal predators may all be needed to promote success of restocking programs on California rangelands.

During the last decade, scientists, resource managers and conservation groups have become increasingly concerned about the lack of young trees in California's native oak stands. Poor establishment varies geographically and within species, but is common in stands of blue oak (*Quercus douglasii*), the species most widely distributed on the state's rangelands.

Blue oak seedling establishment appears unrelated to regeneration. While research has documented the repeated appearance of abundant numbers of seedlings (defined as plants less than 12 inches high), relatively few plants mature to sapling size, 12 to 60 inches tall or larger. These observations bring into question the ability of blue oak to sustain itself.

We conducted a series of studies to identify the impacts of selected factors on the growth and survival of blue oak seedlings using directly planted acorns and transplanted nursery stock. The studies took place in the South Sierra Hardwood Range region in Madera County. Among the factors we studied were: (1) competition from annual herbaceous plants (seedlings from directly planted acorns); (2) small mammal depredation; and (3) irrigation for seedling establishment. Information is intended to support restoration activities where natural establishment is inadequate.

Annual grass range site

The studies were initiated in 1985 at the San Joaquin Experimental Range, a

Protection against aboveground herbivory by rodents encourages both growth and survival.

U.S. Forest Service research facility administered by California State University, Fresno. The area is about 1,000 feet in elevation, and representative of the annual grass range in much of the southern Sierra Nevada foothills. Vegetation consists of open stands of blue oak, scattered interior live oak *(Q. wislizenii)* and gray or foothill pine *(Pinus sabiniana)*, along with an understory of annual grasses and forbs that grow until all available soil water is exhausted.

Soils present are Ahwahnee and Vista rocky coarse sandy loams with minimal profile development overlying granitic parent material. Two soil families are represented: coarse, loamy, mixed, thermic Mollic Haploxeralfs (Ahwahnee); and coarse, loamy, mixed, thermic Typic Xerochrepts (Vista). These coarse-textured soils vary in depth because of the presence of boulders and bedrock. In areas free of rock outcrops, the root zone is moderately deep (20 to 40 inches) to deep (40 to 60 inches or more), and available soil water ranges from 0.09 to 0.12 inches per inch of depth.

Annual rainfall was below average for most of the study period, with rainfall averaging less than 75% of the 60-year average for five successive growing seasons from 1987 to 1992. During the seven seasons in which data were collected, rainfall ranged from a high of 26 inches in 1992–93 to a low of about 10 inches in 1993–94.

Planted acorns

In late summer and early fall, we collected blue oak acorns representing local ecotypes. We planted the acorns within deer-proof enclosures in late fall (November to December) in 1985, 1987 and 1988. The 1985 planting also included locations outside enclosures. The experimental design was a randomized complete block with four replications. Each replication consisted of 100 acorns planted in four parallel rows. Rows were spaced 1 foot apart, with 25 acorns planted in each row, also 1 foot apart.

Main plot treatments for the first two plantings included chemical weed control and no weed control to measure the effect of competition on oak growth and survival. These treatments were repeated in the 1988 planting, to which we added a third treatment — weed control and irrigation. We used drip irrigation to apply 1 gallon of water weekly to each emerged seedling from mid-June to mid-September, 1989.

Weed control was maintained in the 1987 and 1988 plantings for 3 years, then terminated for several reasons: (1) maintenance of bare soil aggravated erosion, (2) the herbicides had residual effects, which provided adequate control, (3) the reservoir of weed seed in the soil was reduced; and (4) the nature of mortality after 3 years suggested that sustained weed control had become unimportant—rodent depredations were the main problem.

Following emergence, screens were installed to protect seedlings in the 1987 planting from small mammal predation. Half of those in the 1988 planting were also protected, creating a split on main plots. The screens used were 14-strand, rigid plastic seedling protectors 2 inches in diameter and 16 inches high.

Small mammal depredation confounded measurement of emergence in all plantings. Acorns were dug up before and after seedling emergence, before screens could be placed. The 1985 planting was destroyed in this manner and could not be replanted. Ground squirrels *(Spermophilus beecheyi)* were suspected to be a culprit. Subsequent plantings were made after the local ground squirrel population was reduced, but we used poison bait to maintain squirrel control throughout the study.

Nursery stock

To complement the acorn seeding, 2-month-old nursery stock was planted in winter 1987–88, using the same experimental design with four replications for each treatment. The stock was propagated from acorns collected in 1987. Each replication consisted of 50 transplants divided into four rows, with transplants placed 2 feet from neighboring plants. This spacing created a staggered pattern with each row alternating between 12 and 13 transplants. As with the directly seeded acorns, weed control was maintained for 3 years, after which the residual effects of the chemicals provided adequate control. Treatments included: (1) no screen protection, (2) screen protection, and (3) screens plus irrigation with water applied at weekly intervals in the same manner as the acorn trials. For 2 consecutive years, only half of the irrigated treatment in each replication was irrigated during the second growing season.

In winter 1990–91, underground screen protection was put in place to test its efficacy against gophers

(Thomomys bottae), a threat both to directly seeded acorns and the nursery stock. The experimental design was used with six replications. Each replication consisted of 50 seedlings propagated from the 1990 collection, half of which were protected by underground tubes of rolled and stapled aluminum screen 2 inches in diameter and 18 inches long. Tubes were placed in holes augered 18 inches deep, which were partially filled with tamped soil, and the seedlings were planted in the last 6 inches of each tube. The planting pattern was the same as that used for the earlier transplant trial, but 10% could not be planted because boulders and bedrock were in the way. After planting, seedlings were protected with aboveground plastic screens and irrigated for the first season. Weed control was maintained for 2 seasons.

Data collected from all trials were evaluated by analysis of variance. Measurements included percentage of emergence; percent survival, measured each year in the spring after bud break; and heights of plants each fall. In measuring height, the longest stem was used if branching occurred. Unless otherwise noted, significant effects were separated by the Least Significant Difference method and reported at the 95% confidence level.

Results for planted acorns

Seedling emergence and survival. Emergence in the 1987 seeding was poor, but was still five times greater in plots with weed control than without it. No seedlings survived longer than 3 seasons without weed control (table 1). Emergence in the 1988 seeding was statistically unaffected by weed control, averaging 50%, but again, seedlings without weed control were dead after 2 seasons (table 2).

Mortality rates were high, even with weed control. In the 1987 seeding, of those that emerged, less than one-third survived beyond the first season; this rate continued to decline to less than 3% of emergence by 1994 (table 1). The 1988 seeding showed similar dramatic mortality rates. The average 1994 survival rate was 12% of emergence.

Aboveground screen protection had no observed beneficial effect, and there was no consistent year-to-year interaction between weed control and screens (table 2). However, the impact of screen protection may have been obscured by damage caused by pocket gophers, which attack from below ground. In the months between April and October 1990, gophers killed 32% of the protected seedlings from the 1988 planting. In contrast, only 19% of the unprotected seedlings were killed by gophers. This difference was significant ($P \leq 0.05$). Only dead seedlings with easily identified gopher damage were included in this category. We measured gopher-caused mortality by examining dead plants to determine whether they had been cut below ground.

In weed control treatments, mortality was higher with irrigation and more of this loss was attributed to gophers. Seasonal survival in the irrigated treatment ranged from 60% of the unirrigated treatment in 1990 to 40% in 1994 (table 2). In all years except 1990, this difference was significant ($P \leq 0.05$). Over the five growing seasons, mean survival without irrigation was about twice that of the irrigated treatment.

Height. Unirrigated seedlings from the 1988 seeding that were protected were twice as tall as unprotected seed-

TABLE 1. Emergence and survival of acorns sown through 4 seasons in the 1987 fall acorn seeding established with and without weed control

	Emergence*	Survival				
Treatment	1988	1989	1990	1991	1992	Mean effect of control
	%					
No weed control	3.8	0.2	0.2	0.2	0	0.9
Weed control	21.0	6.2	4.5	3.2	3.2	7.6†
Mean effect of years	12.4a‡	3.2b	2.4b	1.8b	1.6b	

*All emergents initially protected with screen. Observations made in spring after bud break.
†Mean effect of control is different ($P \leq 0.05$) by LSD Separation.
‡For mean effect of years, values not followed by the same letter are different ($P \leq 0.01$) by LSD Separation.

TABLE 2. Emergence and survival of acorns sown through 5 seasons in the 1988 fall acorn seeding established with and without weed control

		Emergence and survival*			
			Weed control		
Year	Screen protection	No weed control	No irrigation	1989 irrigation	Mean effect of protection
		%			
1989 (Emergence)	NA	46	54	53	NA
1990	No	1	30	20	17
	Yes	0	22	14	12
Mean Effect of Treatment		0.5b†	26a	17a	
1991	No	0	17	10	14
	Yes	0	17	6	11
Mean Effect of Treatment		NA	17a	8b	
1992	No	NA	9	6	7
	Yes	NA	16	3	10
Mean Effect of Treatment		NA	12a	5b	
1993	No	NA	7	6	7
	Yes	NA	14	3	9
Mean Effect of Treatment		NA	11a	4b	
1994	No	NA	7	5	6
	Yes	NA	11	2	7
Mean Effect of Treatment		NA	9a	4b	

*Half of all emergents protected with screens, and half of all emergents in weed control were irrigated in 1989. Observations made in spring after bud break.
†Values for each year not followed by the same letter are different ($P \leq 0.05$) by LSD Separation.

lings, 11 inches compared to 5.5 inches, a significant ($P \leq 0.05$) difference. Unprotected seedlings, measured in 1993, showed no difference in height whether irrigated or not. The average height was 6 inches. An inadequate number of plants receiving both irrigation and protection survived to reliably estimate the height for those seedlings.

Although screen protection had a significant effect, its value was compromised by the height of the screen. Many protected seedlings were clipped off above the 16-inch screens. The height of the damage and character of the clipped surfaces suggest rabbits (*Sylvilagus* spp.) were the primary cause of this small mammal predation.

Again, lack of surviving plants prevented a height comparison between treatments in the 1987 seeding. By 1993, however, the average height of the surviving seedlings growing weed-free with protection was 7.5 inches. Photodecomposition of screens after two seasons may have allowed depredation, which restricted seedling height.

Nursery stock survival

After one season, nursery stock that was planted in winter 1987–88 and screened and irrigated survived at nearly twice the rate of stock that was screened but not irrigated. The latter survived at a rate more than three times that of seedlings that received neither treatment (table 3). Irrigating a second season had no influence on survival. In the screened treatments, survival of irrigated plants declined more rapidly during the first three seasons, but there was no difference in survival among screened treatments in the four seasons beginning 1991. After six seasons, average survival for screened plants was four times that of unscreened plants.

Gophers were responsible for nearly 60% of the losses in the two irrigated treatments, again suggesting irrigation may have encouraged gopher depredation. Underground screens installed in the 1990–91 season appeared to provide some protection, with nearly 90% of protected seedlings still alive in spring 1994. By contrast, less than half of unprotected seedlings were still alive. This was a highly significant ($P \leq 0.01$) difference.

In the 1987–88 trial, screened plants showed no significant differences in height after 1989, when height was first measured (table 3). Irrigation stimulated growth in the first year ($P \leq 0.05$), but did not promote additional growth in the second year. The apparent unsustained differential in growth after irrigation ceased may represent the combined effects of rabbit depredation and discontinuing irrigation. Too few unscreened, unirrigated seedlings survived to provide a current estimate of height. However, when last measured in 1990, height was 33% of screened and irrigated treatments ($P \leq 0.05$). At that time, the data from the few surviving plants were too variable to analyze differences in which the presence or absence of screens was the only factor.

Weeds, rodents hinder seedlings

Abundant evidence exists throughout North America that control of herbaceous vegetation benefits the survival and growth of oaks and other hardwoods, whether propagated naturally or artificially. This finding is supported by our studies and others using blue or valley oak (*Q. lobata*). Other investigations have found that a decline in rainfall, combined with annual grass competition, greatly reduced blue and valley oak seedling establishment.

The value of aboveground protection against rodent depredation found in our trials has also been demonstrated in other hardwood studies. A study conducted at the UC Hopland Research and Extension Center (HREC) in Mendocino County from 1989 to 1994 found that blue oak seedlings, protected by aboveground screens and weed control, survived at twice the rate of unprotected seedlings, and were three times as tall. Protected blue oak nursery stock planted in winter 1987–88 and growing weed-free at the UC Sierra Foothill Research and Extension Center in Yuba County also survived in double the numbers of unprotected plants, and were 70% taller than unprotected seedlings. In a similar planting of blue oak nursery stock at HREC, survival with protection was nearly 10 times that of unprotected seedlings.

Using underground screens to protect against gophers has also been studied on valley oak in San Luis Obispo County, using methods similar to those in our study without any adverse effects on plant growth. As the

TABLE 3. Survival through 6 seasons and height in 5 consecutive years of 2-month-old nursery stock planted weed-free in winter 1987–88

Year	No screens	Protective screens		
		Not irrigated	Irrigated 1988	Irrigated 1988 & 1989
		Survival*		
		%		
1989	12c†	42b	77a	76a
1990	8c	26b	49a	46a
1991	6b	20a	28a	25a
1992	5b	17a	24a	22a
1993	5b	16a	23a	22a
1994	5b	14a	21a	21a
		Height‡		
		inches		
1989	3.1c	6.3b	12.6a	13.4a
1990	4.7b	9.4ab	13.8a	14.6a
1991	§	12.2a	14.2a	17.3a
1992	§	20.5a	17.3a	18.9a
1993	§	21.7a	16.9a	19.7a

*Survival measured in spring after bud break.
†Values not followed by the same letter in each year are different ($P \leq 0.05$) by LSD Separation.
‡Height measured in fall. 1 cm = 0.3937 in.
§Too few seedlings for reliable estimate.

seedling grows, its expanding root mass puts pressure on the slowly oxidizing screen tubes, causing the screen tubes to open along the seams, allowing unrestricted growth.

The underground screens we used may have been longer than needed. Most gopher foraging burrows are found at a depth of 6 to 8 inches, so underground screens shorter than 12 inches might provide adequate protection.

In the 1988–89 trial, planted acorns that were protected only by aboveground screens suffered higher gopher depredation as compared to acorns not screened. This was similar to the mortality seen in the valley oak study. We speculate that the rodents somehow distinguish between the two groups of seedlings; the greater vigor and root reserves of protected seedlings may make them more attractive to gophers.

While other researchers have obtained higher oak seedling survival with supplemental water in Tuolumne County, irrigation did not improve survival in our plots. In our study, irrigation in a naturally dry setting appeared to attract gophers, contributing to differential mortality in the 1988 acorn seeding and accelerated mortality, initially, for nursery stock planted in 1987–88. Applying water apparently improved burrowing conditions, giving the gophers easier access to seedling roots. Water also may have produced healthier seedlings that were more attractive to rodents.

The concentration of planted acorns and nursery stock in this study also may have contributed to attack by rodents. Wildlife biologists have determined that gophers use the sense of smell and other senses to locate food. Thus, seedlings planted in closely spaced geometric patterns may be more vulnerable to predation than those approximating the more random natural distribution of oak trees.

Although rodent depredation influenced survival, the effect of a succession of drought years cannot be ignored. The average annual rainfall was only 65% of the long-term average during the first two growing seasons for the 1987 and 1988 seedings. We suspect low rainfall aggravated an already stressful situation created by droughty soil.

Attack from belowground by pocket gophers threatens survival of blue oak seedlings and saplings.

Conclusions

Competing herbaceous vegetation can severely limit the emergence of oak seedlings from planted acorns and, more importantly, may prevent the development of seedlings into saplings. Weed control, practiced for two or more seasons, may be necessary to successfully maintain and restore blue oak stands in California.

Weed competition is only one of several obstacles to oak establishment. Site selection must also be considered. Restoration projects should be undertaken on sites where the species naturally occurs. Boulders and other conditions below the surface may restrict seedling growth. Careful review of appropriate soil surveys is necessary before initiating planting activities.

Preventing large and small mammal depredation is as critical as herbaceous control. Herbivory may vary with time and place, but some level of protection will almost always be needed until oak trees are big enough to resist attack. Experience suggests that gophers present the longest threat: oak roots can remain vulnerable to attack until trees are 2 or more inches in diameter at the soil surface.

The type of aboveground protection that is most effective will depend on the nature of the threat. The coarse plastic screens used in this study were adequate to protect against small rodents. However, protection against insects and even smaller rodents, such as meadow voles (*Microtus* spp.) and deer mice (*Peromyscus maniculatus*), requires a finer mesh. A fine mesh defense, such as window screen cages, has been used successfully to exclude grasshoppers (*Melanoplus devastator*).

Survival of screened, unirrigated 1987–88 nursery stock was about 25% greater than that of similarly treated seedlings developed from directly planted acorns. However, costs of propagating, transporting and planting this nursery stock make it economically unattractive on rangelands, a conclusion reached by others in the Tuolumne County study.

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Source -
Integrated Forest Pest Management Initiative
Annual Report 1994-1995
Canada's Green Plan
Natural Resources Canada, Canadian Forest Service
Sault Ste. Marie, Ontario, Canada

The Integrated Pest Management in Seed Orchards Network

Dr. Jon Sweeney/Coordinator

Seed orchards are an important component of tree improvement programs. They provide genetically improved seed for accelerated fibre production in forest plantations, and contribute significantly to the sustainability and competitiveness of Canada's forest sector. Insects and disease can have a severe impact on seed production, causing losses of greater than 60% in some years. The goal of the IPM in Seed Orchards Network is to develop ecologically acceptable and practical pest management tactics for key seed and cone insects and diseases in Canadian seed orchards. In addition to the funds we receive from the Integrated Forest Pest Management Initiative of Green Plan, we receive funding and in-kind support from universities, the National Science and Engineering Research Council (NSERC), Forestry Development Agreements, and private industry.

Progress:

Our research has focused on developing: 1) practical methods of population monitoring and damage prediction; 2) behavioral and cultural methods as alternatives to chemical controls; and 3) basic ecological knowledge necessary for the development and effective application of monitoring, damage prediction, prevention, and alternative control tactics. Highlights of our progress in 1994 are summarized below.

Peter de Groot (CFS - FPMI), in collaboration with Gary DeBarr (US Forest Service) and others, is developing pheromone-based tools for the detection, monitoring and suppression of cone beetles in pine seed orchards. Studies comparing pheromone dispensers, trap designs, and trap height suggest the optimal system is a Japanese beetle trap, baited with Phero Tech's bubblecap, suspended in the upper crown of trees. Field trials are planned for 1995 to determine the optimal density of traps per orchard and the relationships between catch and cone beetle damage. A promising control strategy under investigation is the suppression of *Conophthorus* cone beetle populations by the mass trapping of male beetles. Over 5000 beetles were caught in a pilot study carried out in 1993; the beetle population was significantly lower in 1994, when the trapping-out technique was repeated. Replicated field trials will be conducted in 4-6 pine seed orchards in 1995 to determine the effectiveness of the trapping out technique as a population suppression tool.

Jon Sweeney (CFS-Maritimes), Jean Turgeon (CFS-FPMI), Dan Quiring (UNB) and graduate students Laura Fidgen, Martha McClure (UNB), and Eckehard Brockerhoff (U of T) are studying the population dynamics, host location process, and impact of cone maggots (*Strobilomyia* spp.), affecting spruce and larch seed orchards. Partial life tables were constructed for the spruce cone maggots from data gathered in 1992–94. These data indicate that invertebrate predators cause significant mortality in mature larvae and puparia in thesoil. Carabid beetles and ants comprise more than 80% of the total potential predators caught in pitfall traps. Parasitism rates were quite low; the range of parasitoids appears similar to that exploiting *Strobilomyia anthracina* (the cone maggot that infests cones of Norway spruce in Europe). The survivorship data will be analyzed in 1995 and will provide a better

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Funay Model Forest

B.C. Ministry of Forests

Ontario Ministry of Natural Resources

understanding of the natural mortality factors affecting cone maggots; this knowledge is vital for developing alternative control strategies.

We have begun to transfer some cone maggot sampling and damage prediction methods to seed orchard managers. Preliminary sequential sampling plans for predicting seed losses to spruce cone maggots were tested operationally in the Maritimes with the assistance of seed orchard managers. Additional data on the relationship between egg density and seed loss were collected in Ontario to improve the sampling plan in black spruce orchards. Knowledge of the phenology and impact of larch cone maggots arising from M. McClure's graduate work was applied in three orchards in 1994 to determine the need for, and timing of, insecticide applications. Jean Turgeon's "Process" blue sticky trap caught extremely large numbers of larch cone flies in 1994 and shows promise as a tool for monitoring, and possibly controlling, most species of larch cone flies in North America and abroad.

Suzie Blatt, a PhD student with John Borden at Simon Fraser University (SFU), has made excellent progress towards elucidating the pheromone chemistry and pheromone-mediated behaviour of the western conifer seed bug, *Leptoglossus occidentalis*, and assessing the potential for pheromone-based management techniques. A five component alarm pheromone was identified, synthesized, and shown to have significant repellent effects on seed bugs in laboratory bioassays and preliminary field trials.

Field experiments detected a male-produced aggregation pheromone that is released in the fall when the seed bugs are seeking overwintering sites. Both the alarm pheromone and aggregation pheromone have potential as management tools. Plans for 1995 include additional field trials of the alarm pheromones as management tools, and the identification and bioassay of antennally active host-flower volatiles, sex and aggregation pheromones.

Tony Hopkin (CFS-Ontario Region), Ken Mallett (CFS-Northwestern Region) and Michel Dessureault (Laval University) are determining some of the factors that predispose conifers to Armillaria infection. This information will be used to develop a hazard rating system to be used in seed orchard site selection. Greenhouse trials repeated in 1994 confirmed that the incidence of Armillaria infection increased with increased availability of soil moisture and nutrients. Data on the incidence of disease and various factors such as site age, soil texture and fertility, and site history gathered from over 30 black spruce seed orchards and plantations suggest that incidence of Armillaria is associated with deficiencies of calcium and magnesium in the soil, root deformities, sandy soils, and presence of forest debris. Experiments testing the relationship between defoliation-induced stress and Armillaria infection were repeated in 1994 and analysis is underway. The hazard rating system being developed from these data will be validated in 1995.

Rob Bennett and Bev McEntire of the B.C. Ministry of Forests, working in collaboration with Gerhard Gries of the Chemical Ecology Group at SFU. Gary Grant (CFS-FPMI), and

Jean François Landry of the Centre for Land & Biological Resources Research have greatly improved our knowledge of the pheromone chemistry of the fir coneworm, *Dioryctria abietivorella*, and its life cycle on Douglas-fir in B.C. *Dioryctria* adults were caught in pheromone traps from late May through October, with the flight period beginning one month earlier in the interior than on the coast. A range of larval instars were found in cones throughout the summer and fall. It appears that late instar larvae overwinter in silken cocoons within the cones. Several hundred larvae were collected and are being reared for pheromone analysis and morphological examination. Pheromone trapping and cone sampling will be repeated in 1995 to determine the relationship between trap catch and cone damage and to further elucidate the fir coneworm's life cycle. The ultimate goal is to provide orchard managers with an operational monitoring program for *Dioryctria*.

Gary DeBarr, SE Station

White Cone Beetle -
paper abstract

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PHEROMONES IN WHITE PINE CONE BEETLE, *Conophthorus coniperda* (SCHWARZ) (COLEOPTERA: SCOLYTIDAE)

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(Received May 21, 1994; accepted September 10, 1994)

Abstract—Female white pine cone beetles, *Conophthorus coniperda*, attacking second-year cones of eastern white pine, *Pinus strobus* L., produced a sex-specific pheromone that attracted conspecific males in laboratory bioassays and to field traps. Beetle response was enhanced by host monoterpenes. The female-produced compound was identified in volatiles collected on Porapak Q and in hindgut extracts as (+)-*trans*-pityol, (2*R*,5*S*)-(+)-2-(1-hydroxy-1-methylethyl)-5-methyltetrahydrofuran. Males and females produced and released the (*E*)-(−)-spiroacetal, (5*S*,7*S*)-(−)-7-methyl-1,6-dioxaspiro-[4.5]decane, which was not an attractant for either sex, but acted as a repellent

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Sandy Kegley, R-1
Ray Hoff

Genetics and Physiology
of Whitebark Pine

Genetics and Physiology of Whitebark Pine

Ray J. Hoff
October 1994

Contents

Blister Rust Resistance
Whitebark Pine

Part One

Blister Rust Damage in Natural Stands

The objective of this study is to map out blister rust damage over the range of whitebark pine. This will enable us to develop optimum management strategies, e.g. areas like northern Idaho/northwestern Montana where blister rust is most damaging may require an aggressive genetic program whereas areas like Yellowstone where blister rust is still a minor pest may need only a monitored "let nature do it" management system. This study was started in 1991 and several dozen stands have been surveyed by Ray Hoff, Bob Keane, Ward McCaughey, Kate Kendall, Gallatin National Forest and probably others. Kate hopes to get support for this study and will then maintain the data set.

Part Two

Artificial Inoculation of Seedlings

In 1989 I started a progeny test, a preliminary test, with the objectives to: 1) learn how to grow and maintain seedlings of whitebark pine and 2) to determine the level of resistance in whitebark and to see if it is associated with levels of mortality in natural stands.

With much help from Jan Scheffer (manager and part owner of the Western Forest Systems, Inc. in Lewiston, Idaho) I was able to grow and maintain most of the seedlings. I lost many seedlings, about 300 out of about 1,000, from various root rots; however I was pleased that I killed most of the seedlings with blister rust.

The blister rust data from this study is very encouraging. Natural stands with high mortality due to blister rust appears to have high resistance and those from moderate and low mortality much lower resistance (Table 1).

Table 1. Level of resistance of seedlings artificially inoculated with blister rust--two year data

Blister Rust Condition	Seedlings	
	Total	No Cankers
	#	# %
High Mortality	319	140 44
Moderate Mortality	136	24 18
Low Mortality	243	10 4

This is a lot more resistance then I expected. There will likely be a few more cankers showing up but I don't expect to many. Nearly 90% of the seedlings that had cankers in September 1994 were already cankered by September 1993. Then too, more resistance will likely show up--bark resistance was still low in May of 1994, but sometime after that resistance systems in the bark went into action and successfully killed the fungus in several seedlings. In September 1994 previous cankers had become bark reactions and the level of resistance took an upward jump.

There were several families that had very high resistance

(Table 2). Three families in particular catch my eye. One is family 33 from the Gisborne stand, a stand with 90% mortality. Family 33's main resistance mechanism was premature shedding of blister rust infected needles. This means that (using western white pine as a model) sometime between the 9th month and the 12th month after artificial inoculation the infected needles dropped off. This very effectively separates the fungus from the primary infection court, the needle, and the stem. The second is family 17 from Lunch Peak also a stand with over 90% mortality by blister rust. In May 1994 only three seedlings out of the 24 were resistant but in September of 1994 eleven more trees showed resistance due to reactions in the stem that killed the fungus. A third kind of resistance is illustrated by a third family. This is family 20 from Lunch Peak. It has 13 seedlings out of 25 that were resistant to blister rust via a trait called fungicidal short shoot. Here the fungus grows down the needle and when it grows into the short shoot some kind of reaction is turned on that kills the fungus. It is recognized by seedlings that have blister rust needle spots in nine months and twelve months after inoculation but never show up with a canker.
A fourth reaction is also evident and this is a trait called "no spot no canker". This trait could be an escape, i.e., for some reason they did not become inoculated. In this test I favor escape since six out of the eight seedlings with no spots/no canker were from low mortality stands.

The high amount of variation among the families within stands is really exciting as is the presence of some genes for resistance even in the low mortality stands.

Table 2. Blister rust resistance in families, individual selected trees, from within four stands

Stands	Family	Tot	No Canker		---Defense Symptom--- NoSp	Shed	Shoot	Bark
		#	#	%	#	#	#	#
Gisborne	1	15	8	53	0	4	4	0
high	2	11	1	9	0	0	0	1
rust	5	25	7	28	0	1	4	2
mortality	7	10	0	0	0	0	0	0
	8	14	10	71	1	4	5	0
	9	16	4	25	0	2	0	2
	10	15	8	53	0	2	4	2
	32	12	5	42	0	4	1	0
	33	17	13	77	0	11	2	0
	34	14	8	57	0	5	2	1
	36	8	3	37	0	1	1	1
	Total	157	67	43	1	34	23	9
Lunch peak	15	15	5	33	0	3	2	0
high	16	11	6	55	0	3	3	0
rust	17	24	14	58	0	1	2	11
mortality	18	17	9	53	0	4	4	1
	19	9	3	33	0	0	1	2
	20	25	16	64	0	0	13	3
	21	20	9	45	0	5	3	1
	22	16	8	50	0	5	2	1
	23	16	3	19	0	1	0	2
	Total	153	73	48	0	22	30	21
Cooper Pass	24	27	0	0	0	0	0	0
moderate	25	25	10	40	0	1	8	1
rust	26	23	2	9	0	0	2	0
mortality	27	21	1	5	0	0	1	0
	Total	96	13	14	0	1	11	1
Brundage	37	24	1	8	0	0	0	1
low	38	27	0	0	0	0	0	0
rust	39	19	0	0	0	0	0	0
mortality	40	27	2	7	2	0	0	0
	41	22	1	5	1	0	0	0
	42	11	0	0	0	0	0	0
	43	24	0	0	0	0	0	0
	44	17	4	24	2	1	0	1
	45	25	0	0	0	0	0	0
	46	20	1	5	0	0	1	0
	Total	216	9	4	5	1	1	2
Table Total		622	162	26	6	58	65	31

The remainder of the test data is shown in Table 3. This is stand data where the seed collections of the individual trees from the stands where bulked. Not much to say about this data except that many more seedlings are needed to really characterize the rust resistance within these stands. In the future 100 or more seedlings will be included.

Table 3. Blister rust resistance in families, individual selected trees, from within four stands-

Stands	Family	Tot	No Canker		---Defense Symptom--- NoSp	Shed	Shoot	Bark
		#	#	%	#	#	#	#
Freezeout high mort	--	9	0	0	0	0	0	0
Seven Devils mod mort	--	17	6	35	1	2	2	1
Saddle Mtn. mod mort	--	23	5	12	0	3	0	2
Porphyry low mort	--	16	0	0	0	0	0	0
Palmer Mtn. low mort	--	11	1	9	1	0	0	0

This is just the first test and with it we have gained additional information on the nature of resistance to blister rust in whitebark pine and we have found several trees that we use for seed orchards, if that is what we wish to do, and we can increase the numbers of resistant seedlings by rooting.

The next step is to locate and collect seed from many more resistant candidates from the entire range of whitebark pine, especially for those areas that have been decimated by blister rust.

Maybe in the next inoculated progeny test we could also incorporate DNA and enzyme analysis. If we are lucky maybe we will find useful associations.

Part Three

Locate and Describe Candidate Trees

In conjunction with surveying natural stands for blister rust I have, and hope others have to, been looking for blister rust resistant candidate trees. In 1994 several of these candidate trees have been tagged and description forms filled out (description form is attached). This includes such things as location, presence of cankers, cones, pollen, conelets, height, diameter and age. Tags used were ear tags for cows. These were first marked with a butane pen that burns the number into the tag and then a permanent marking pen (tag pen) is used over the burn marks. This should last for many years.

Criteria of Candidate trees:

1. Trees should be easy to climb, not over 60 to 70 feet or so depending, but big enough to produce cones.
2. Not more then a few hundred feet from a road, trail or easily described fixed point. There are lots of candidate trees in most stands so there is no need to choose trees that will be hard to find again.

I have been using the following method to number candidate trees.

Candidate trees found at Pyramid pass that were found by John Schwandt and Ray and Bettie Hoff were tagged September 22, 1994 were numbered PYR.1, PYR.2, PYR.3, PYR.4, PYR.5.

Candidate trees found at Northwest Peak found by Ray and Bettie Hoff September 28, 1994, were numbered NWP.1, NWP.2, NWP.3, NWP.4, NWP.5.

The main difficulty is to establish a fixed point that can be found again. In western white pine a tag was also placed on a tree next to a road or trail but this clutters things up. What we did at Pyramid Pass and Northwest Peak is to photograph fixed objects such as huge boulders, putting a cairn on a large rock, or previously blazed trees.

LOCATION OF WHITEBARK PINE TREES

THAT APPEAR TO BE RESISTANT TO BLISTER RUST

TREE NUMBER:_____.

LOCATED BY:_____, ORGANIZATION_____.
DATE FOUND:_____.

NAME OF MOUNTAIN PEAK OR DRAINAGE:_____

STATE:_____.

TOWNSHIP_____, RANGE_____, SECTION_____.

LATITUDE_____, LONGITUDE_____, or UTM_____.

ELEVATION: FEET_____, or METERS_____.

COMPASS DIRECTION FROM FIXED OBJECT:_____.

DISTANCE FROM FIXED OBJECT:_____.

OTHER LOCATION IDENTIFIERS:_____.

_____.

INDIVIDUAL TREE DATA:

Hgt._____, Diam._____, Age____,

Cones____, Pollen____, Cankers____, Conelets_____.

BLISTER RUST MORTALITY IN STAND, CHECK ONE:

90% or more____, 50-90%____, 1-50%____.

COMMENTS:

Part Four

Artificial Pollination

Artificial pollination of a 90% rust mortality stand with pollen from a 90% rust mortality stand and with pollen from 0% rust mortality stand. This is a cooperative study between Ray Hoff, INT, Moscow and Ward McCaughey, INT, Bozeman. Objective is to determine the growth and rust resistance of a stand that has had high mortality and is therefore highly fragmented. Rust resistance will increase but will growth and vitality be good enough to produce a new stand. Comparison would be with crosses in a stand with no mortality. Stands selected were Gisborne Lookout area, near Priest Lake, Idaho as the high mortality stand and Palmer Mountain near Gardiner, Montana just north of Yellowstone National Park.

Ten trees were selected as flower trees at each site and ten separate trees were selected as pollen trees. Crosses were completed at Gisborne in 1993 and cones collected in 1994. Still need some open-pollinated cones from Gisborne. No crosses have been made at Palmer because of weather conditions; however, sufficient pollen was produced to use at Gisborne.

Cones collected in 1994 at Gisborne were first given to Sandy Kigley, FPM at Coeur d'Alene to determine the extent of insect infestations. She found 67% of the cones infested and she is in the process of rearing out insects.

Part Five

Vegetative Propagation

Grafting of whitebark pine on western white pine and ponderosa pine. Objective is to see if whitebark pine will grow faster on western white pine or ponderosa pine root stock. A second objective is to see if it is easier to grow and maintain whitebark pine.

In 1994 10 grafts of whitebark pine were made on western white pine, two were successful and they are still alive.

B. Rooted cuttings. Objective is to propagate seedlings of resistant whitebark pine. We could then mass produce resistant seedlings.

In 1994 49 cuttings of whitebark pine were stuck, seven successfully rooted.

Adaptive variation

This is not my study area but I initiated this study in 1989 just because I knew that it would take many years to collect cones from all the stands required for the study. Objective of this study is to develop seed transfer rules for whitebark pine. Design calls for at least 100 stand collections from Regions 1 and 4 (Idaho and Montana) plus several more from Washington, Oregon, California, Nevada, Wyoming, British Columbia and Alberta.

By fall 1992 over 50 stands had been collected. Nineteen ninety three and 1994 were not good cone years; however, a few cones were collected from some stands. I have seen conelets on many trees in 1994. So 1995 should be a good cone year. Lets plan to collect cones in 95.

This study does have many phases. DNA and enzyme analysis could be completed on foliage from natural trees right now, and this should be done. On the other hand, the common garden and outplantings are still several years in the future.

My thoughts on this study are:

Do DNA and enzyme analysis for the same stands and same trees for which cones were collected, if possible.

Do DNA, enzyme, morphology, physiology and other work that various workers can think of on the seedlings.

I hope that we can all share in gathering data.

Phenological surveys.

I have observed:

1. That growth of whitebark pine at Gisborne starts and ends before the last frost, i.e. the new tissue most not be very susceptible to frost.

2. Cone production appears to be controlled more by weather conditions than the physiology of the tree. A frost in 1992 killed nearly all the pollen and flowers. Although in 1993 there was no frost that killed the pollen and flowers, at least at Gisborne, weather conditions were still to wet to permit adequate pollination. In 1993 I pollinated flowers and Gisborne and had good success with cones produced in 1994; on the other hand natural pollination did not appear to be sufficient. When I was pollinating I was often covered with natural pollen and there were hundreds of flowers. In August and September these flowers had developed into fairly sizeable conelets but only about 75% the size of artificially pollinated conelets and in October nearly all of the naturally pollinated conelets aborted. Very few of the artificially pollinated conelets aborted. My explanation is that I found very few nice days that I was willing to climb the trees to pollinate, i.e., the conditions were just too wet for good pollination. Pollen bags, on the other hand, kept the flowers warmer--I also pollinated the flowers three time, which probably helped.

Anyway, I think we should start a survey of natural parameters of growth in nature, and determine the association of weather conditions with flower and pollen production and conelet and cone production survival.

Bill Kilroy, MTDC

Single Tree Spray System

May 22, 1995

TRIP REPORT

Subject: MTDC staff trip to the Oconto Seed Orchard on the Nicolet National Forest, Antigo, Wisconsin.

Dates: May 8-12, 1995

Prepared by: Bill Kilroy

Objective: To install single tree sprayer systems in 40 trees at the Oconto Seed Orchard, based on experience gained at the Coeur d'Alene, and Beech Creek Orchards installing similar systems.

Contacts: Bill Sery, Oconto Tree Seed Orchard Manager
Dan Rolo, Tractor Operator
Bill Wesner, Tractor Operator
Lin Klapps, Biological Aid
April Schreiver, Biological Tech.

MTDC Participants: Mike Huey, MTDC Technician
Winston Hayden, MTDC Technician
Mark Wiggins, MTDC Photographer
Bill Kilroy, MTDC Technician/Writer

Activities:
On May 8, 1995, Mark Wiggins, Winston Hayden, and Bill Kilroy traveled to Wausau, Wisconsin by air. They were met at the airport by Mike Huey and driven to Antigo, the closest town to the Oconto Seed Orchard. Huey had arrived on site Wednesday May 3, to assist in data collection for another FPM/MTDC project: Thermal Insect Control.

On May 9, Wiggins, Hayden, Huey and Kilroy arrived at the orchard at 0730. Bill Sery made a short presentation outlining the Oconto Seed Orchard operation in general, and describing the work that had been done to develop a strain of Eastern White Pine with a heightened resistance to Blister Rust. He noted there were 40 trees in his orchard that he had selected for the single tree sprayer evaluation. These trees were from the Blister Rust Resistant Group. The spraying would be done to control the Eastern White Pine Cone Beetle.

The day was overcast with intermittent heavy rain and wind, so the decision was made to pre-assemble the plumbing inside, and to travel to Green Bay for some additional parts. On Wednesday, May 10, and Thursday, May 11, all participants worked in the orchard placing the Single Tree Spraying Equipment in the designated trees. Mark Wiggins took pictures of all phases of the operation and then left on Thursday.

Sery had two self-propelled lifts rented for the operation, and though the ground was soft from days of rain, they performed well. Two men went up in each bucket to attach the spray equipment to the tree, while one helper remained on the ground to hand them the pipe at each tree. These trees were for the most part, 35 feet high. The nozzles were set two feet above the tree

tops. It took approximately 15 minutes to fasten the rigid piping properly in each tree and to attach the flexible pipe. Much of the time, however, was spent repositioning the lifts, as the 40 trees were in groups of four or five spread here and there about the south-west corner of the orchard.

The crew completed installation of single tree spraying systems in 36 of the designated orchard trees, working until 1630 hours each day, The orchard crew said they would have no trouble completing the job on Friday morning.

In testing the system, Sery was satisfied with the volume of spray released and the apparent pattern. Pump pressure began at 45psi, but later was dropped to 30psi. Sery was also satisfied with the system drain time of 10 seconds.

Equipment Configuration:
The Single Tree Sprayer Systems installed in the Oconto Orchard trees were configured as follows progressing from top to bottom: Rainbird 1800 Series, 15F plastic sprinkler nozzle with 15 feet radius, 30 deg. trajectory, and 3.7 gpm flow at 30 psig. The basket strainer supplied with the nozzle was used.

The nozzle was screwed onto a PA-8S shrub adapter. The shrub adapter was screwed onto a 1/2 inch male pipe thread fitting glued to the top of the 1/2 inch PVC.

20 feet (two 10 feet lengths) of 1/2 inch PVC pipe was used. This was electrical conduit, gray in color and chosen because it is UV resistant. As this pipe is designated for conduit use, no psi rating is listed by the manufacturer. White PVC couplings were used because of availability. There is a UV resistant water pipe designed for outside use. This pipe is, however, not readily available and is more expensive.

The PVC was fastened to the tree with two "TV Antenna Lead-in Standoffs". These are standard Radio Shack items and are used without the center plastic insert. The 3 1/2 inch standoff is catalog number 15-853, and the 5 1/2 inch standoff is catalog number 15-854. A hose clamp was positioned above the standoffs to keep the pipe from slipping down. Dependent on the diameter of the tree stem at the top, a plastic tie was sometimes substituted for the top standoff.

A 1/2 inch female pipe thread fitting was glued to the bottom of the PVC pipe, and a 1/2 inch male pipe thread-to-1/2 inch hose barb fitting screwed into the female fitting.

Fifty feet of 1/2 inch Polyethylene 100psi utility (flexible) pipe was pressed on to the hose barb, and secured with a hose clamp.

On the bottom (ground) end, a 1/2 inch male pipe thread-to-1/2 inch hose barb fitting was pressed on and secured with a hose clamp.

A 1/2 inch female pipe thread-to-1/2 inch female hose adapter (with washer) was screwed onto the hose barb fitting to complete the assembly. This was taped over to preclude insects or debris entering the system.

A replaceable cartridge "whole house" type water filter with a 4gpm flow @ 120 psi rating was installed between the tree sprinkler system and the tractor driven pump at the pump discharge.

Please note that the Rainbird 1800 series "pop up" sprinkler head was not used on the Oconto SO. It is an unnecessary addition to the equipment list. Deleting this piece and using a PA-8S shrub adapter makes for a less expensive and cleaner system with less wind resistance at the top of the tree.

Because of a slow drainback problem at the Beech Creek Seed Orchard, a "T" fitting was installed in many of the Oconto systems. This fitting was located at the top of the 20 foot PVC pipe, below the strainer and nozzle. The fitting was installed for the purpose of locating a check valve at the top of the plumbing column and thereby venting the system during the draining process. It was thought that this would solve the "slow drainback" problem. Only one check valve was available at Oconto for testing. All the other "T" fittings were plugged after the test results were evaluated.

In testing the systems at Oconto, there was no difference in the drainback time between the check valve equipped system and a non-check valve system. At Oconto, the complete system could be drained (by gravity) in 10 seconds. Therefore, the "T" fitting and check valve appeared to be unnecessary. It should also be noted that a valve to isolate the tank, and bypass the filter when draining the system should be installed. This was not done initially, and what appeared to be an excessively long drainback time was really caused by siphoning water out of the tank at the same time. Once this was realized, and plumbing changes made, the 10 second drainback times were achieved.

Because leaks were experienced at the hose-clamped joints in the Beech Creek installations, it was decided to try both narrower clamps and heated joints in the Oconto installation. The narrower, 5/16 inch clamps (Ideal number 62606) were used with both unheated and heated poly pipe on some systems. Standard 9/16 inch clamps (Ideal number 6810) were used with heated poly pipe on other systems.

In conclusion:
At this time it would appear that the 1/2 inch gray PVC, electrical conduit, is as rigid as 1/2 schedule 40 white PVC, and can be used to avoid sunlight degradation.

As was mentioned in the Beech Creek Trip Report, the pop-up sprinkler heads are unnecessary, and should be replaced with the PA-8S shrub adapter.

No excessive drainback delays were experienced with the PA-8S adapters, strainers, and #15F nozzles.

Whether 5/16 inch or 9/16 inch hose clamps are used, it is recommended that the poly pipe be warmed with a propane torch just prior to assembly. Locate the clamp around the smooth part of the hose barb fitting, above the barb and near the end of the pipe. Either width clamp will provide a tight joint with preheated pipe. The wider clamp deforms the pipe and fitting somewhat more, but is less likely to be "stripped" in tightening. Heating the pipe also makes for easier assembly when you are leaning from the lift bucket in the tree crown.

On the bottom (ground end) of the Polyethylene pipe, female hose-end fittings were used in the Oconto Orchard instead of the male hose-end fittings used at Beech Creek. This was done to facilitate the use of inexpensive plastic quick-disconnect hose couplers. The least expensive set up, and the most easily closed to bugs and debris, would be one that had a male hose thread fitting on the bottom end of the Polyethylene pipe onto which is screwed a female hose-to-male quick disconnect fitting (WalMart "Good Housekeeping" stock no. WM2975). Putting the male half of the quick disconnect coupling in this position enables it to be easily taped over, or sealed with a plastic cap. The other female half of the quick disconnect coupling can be either the shutoff type with female hose thread (part of WalMart "Good Housekeeping" stock number WM2900), or the normal female half of the coupling with male hose thread (part of WalMart "Good Housekeeping" stock number WM2970), used in conjunction with a female hose-to-female hose adapter on the hose from the pump. These fittings are available through WalMart and are manufactured by Nelson. Also, we have requested information and samples of plastic caps. We will make a recommendation on what might be used to cover the fitting at the base of each tree instead of tape as soon as we find the right cap or plug.

Bill Kilroy
Mechanical Engineering Tech

Dave Rising, MTDC

Single Tree Spray System

United States Forest Service
Department of Agriculture

Technology & Development Center

Ft. Missoula-Bldg #1
Missoula, MT 59801
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File Code: 5E52P64 Date: 08/03/95
Route To:

Subject: Trip Report

To: Dave Rising

Single Tree Spray Systems Inspection

Participant: Diane Herzberg

Monday, July 24th, 1995.

On this day I travelled from Missoula to San Francisco and stayed at Berkeley, California.

Tuesday, July 25th, 1995.

Nancy Rappaport met me at the hotel and drove us to the the Pacific Southwest Research Station in Albany, CA. We exchanged draft copies of our reports on the single tree spray systems(STSS). She is the first author on the report to be published in the Western Journal of Applied Forestry or the Journal of Economic Entomology. I need to prepare a table and explanation of how to determine the amount of pressure required at the pump setting.

We reviewed the draft MTDC progress report of which Nancy will be the second author. Nancy forwarded the results of the pheromone trapping study completed by Jack Stein in 1993 at the site of the sugar pine installations. Nancy will review the recommendations and conclusions and forward her comments later.

Wednesday, July 26th, 1995.

On this day I travelled from Berkeley to Fresno. California.

Thursday, July 27th, 1995.

I met Tom Catchpole of the Pineridge Ranger District in Prather, California. We continued on to Shaver Lake and met Tim Veach of the Kings River Ranger District. We then went to the site of the 3 single tree spray system installations.

As the primary climber, Tim Veach conducted a tailgate safety meeting regarding tree climbing. We examined the tree climbing equipment Tim brought to the site and he instructed me how to use it. We also reviewed climbing safety and rescue procedures.

Inspection of STSS in Tree No. 1.

Tom Catchpole connected the spray system to Tree No. 1. We conducted an operational test using water. The system was intact and operational although the nozzle appeared to have some small blockages in the spray pattern.

After the tree dried, Tim Veach climbed the tree to perform the inspection. He replaced the nozzle and filter. It appeared to be clogged with two small plastic pieces of nylon. The pieces were parts of the roller covers from the pump failure during the 1993 operation.

In addition, the lightweight, nylon firehose was replaced with black polyethylene sprinkler pipe. The nylon firehose held up well during the two years. The brass hose couplings appeared weathered but were intact. There was no evidence of damage due to forest animals. This tree had been banded for squirrels since the system was installed in 1993.

After the hoseline, nozzle, and filter were replaced, Tom Catchpole tested the system with water and the system performed acceptably.

Inspection of STSS in Tree No. 2.

Tom Catchpole performed the operational test to demonstrate the failure of the system.

After the tree dried, Tim Veach climbed the tree to perform the inspection. Along with replacing the sprayhead, an additional 61 cm (2 ft) section was added to the top section of the tree. The sprayhead had an approximately 4 cm (1.6 in) vertical crack on the side. Presumably due to the expansion of frozen water inside the sprayhead.

Tim replaced the sprayhead and extended the upper rigid section to place the sprayhead above the tree.

Tom Catchpole tested the system with water and the system performed acceptably.

Inspection of STSS in Tree No. 3.

Tom Catchpole performed the operational test. The system was intact and operational although the nozzle was approximately 40 cm(18 in) below the top of the leader.

After the tree dried, I climbed the tree to perform the inspection. An additional 61 cm (2 ft) section was added to the top section of the tree. This tree is about 23 m(70 ft) tall and is growing more rapidly than the other two trees. Where the coupling was held against the tree, the coupling had dug into the bark somewhat. I noticed a pink stain on the tree near the quick connect coupling indicating these couplings may allow more leakage than is desirable.

The straps were very tight around the tree. A screwdriver was used to pry the snap buckles open. I adjusted the nylon straps to allow three fingers to be slid between the strap and the tree on the three top straps. A four-finger allowance was used on the lower straps. On one strap the polyethylene pipe was nearly pinched closed.

After I added the extension to the upper section of the spray system, the sprayhead was about 6 inches above the tree leader.

Tom Catchpole tested the system with water and the system performed acceptably.

The spray system and extra equipment remains at the Pineridge Ranger District. Tom Catchpole should be informed of the future status of the project and the future needs of the spray equipment. If MTDC or PSW is not going to continue working with the sugar pine spray systems, I suggest the equipment be released to the district for use with herbicide applications.

Friday, July 28th, 1995.

On this day, I returned to Missoula.

Sincerely,

/s/Diane Herzberg

DIANE HERZBERG
MTDC Mechanical Engineer

cc: Brenda Holland
Keith Simila
Tom Catchpole
Nancy Rappaport

MESSAGE SCAN FOR JACK BARRY

To Safiya
To Paul
CC MH
CC JS
CC Jack
CC Tom
CC NR

From: Nancy Rappaport:S27A
Postmark: Aug 03,95 3:56 PM Delivered: Aug 03,95 3:57 PM
Status: Previously read
Subject: Forwarded: Trip Report

Comments:
From: Nancy Rappaport:S27A
Date: Aug 03,95 3:56 PM
Safiya and Paul-
Just want to let you know that the single-tree system was tested on certified or candidate certified trees, seemed to work well, and seems to be hodling up well into the third season after installation. The minor equipment failures can be easily avoided (see attached). Sandy Kegley and Jack Stein have followed up this work in a seed orchard setting, where proper replication can be more easily done, and I think Jack and Sandy's early results are also promising. The system is also being developed in north-central and eastern seed orchards; indeed current development seems to be focusing entirely on seed orchards. I think it's important for someone to follow up on the original effort, which was to protect cones of rust-resistant certified trees in remote sites. I am supposed to be shifting my research efforts to basic research, so I want to encourage someone else to continue the work with certified trees. If no one picks up the reins, the equipment will be diverted to other uses, and we'll still have no treatment for certified trees.

Previous comments:
From: Paige Hoskinson:R01A
Date: Aug 03,95 4:43 PM
Attached is a copy of Diane Herzberg's trip report following the Single Tree Spray Systems Inspection.

-------=========X=========-------

Bill Sery, R-9

Single Tree Spray System
Thermal Control

FIRST SURVEY

APPLICATION OF ESFENVALERATE
USING AERIAL SPRINKLER SYSTEMS

at

Oconto River Seed Orchard
in WI

Aerial sprinkler systems were installed in 40 white pine trees with the help of Missoula Technology Development Center. Trees that were to be involved in the breeding program or that were involved in special seed requests were selected for sprinkler installation. Previously, much time and money was invested in these trees only to have our efforts eaten by Conophthorus coniperda, the eastern white pine cone beetle.

On May 24, 1995, the first application of esfenvalerate(Asana) was made at a rate of 9.6 oz. of Asana in 100 gallons of water, 10 gallons of mix per tree. On June 26-27, 1995, a survey was taken on the forty trees with sprinklers and ten trees without sprinklers. Ten cones were counted on the north side and the south side of each tree. Cones that were attacked by Conophthorus and those that were not, were tallied. The following table summarizes the results of this tally:

	NORTH		SOUTH	
	Beetles	No Beetles	Beetles	No Beetles
Sprinkler	172(48%)	183	135(46%)	155
No Sprinkler	96(75%)	32	77(75%)	26
Patton Pine	61(43%)	83	53(35%)	96

Overall: Sprinkler - 48%
No Sprinkler - 75%
Patton Pine - 39%

The Patton Pine was calculated as a subset of the data because it is a separate group of trees where a high concentration of sprinklers were installed. This allowed for nearly full coverage of this small group by the spray. The result was better control, possibly because beetles did not come in from neighboring untreated trees. There was no significant difference between the north and south sides of trees. Though still high, beetle infestation was significantly reduced (27%) in treated vs. untreated trees.

Bill Sery
Seed Orchard Manager/Project Geneticist

Operation of a Propane Flamer for Control of White Pine Cone Beetles in a Seed Orchard

1995 Trials

William Sery
USDA Forest Service
Oconto River Seed orchard

Steven Katovich
USDA Forest Service
Northeastern Area

Introduction

In 1994, attempts at killing a high percentage (>90) of white pine cone beetles within their overwintering cones using a trailer mounted propane flamer were not completely successful (Katovich and Sery, 1995). Several trial burns were conducted in 1994 at various fuel moistures. None of those trials consistently killed greater than 75 percent of the overwintering beetle population found in infested cones, though an operational burn done under a 10 acre seed orchard did kill approximately 81 percent of the overwintering beetles. Several limitations were noted with the propane unit used in 1994 and with the study design. These included:

> Much of the heat produced by the burners was escaping upward due to a lack of a shield that would force heat downward onto the cones.
>
> The 1994 study did not document the temperatures generated inside the cones during treatment by the propane flamer.

Due to these problems, the propane flamer used in 1994 was modified to eliminate the excessive loss of heat. Further, the new study design included the measuring of heat within treated cones.

Propane flamers have been used to successfully control insects and weeds in agricultural fields (Moyer 1992) and prescribed ground fires have been shown effective at controlling white pine cone beetles in seed orchards (Wade, et al. 1989) and red pine cone beetles in seed production areas (Miller 1978). The technique and technology should transfer to seed orchard following some equipment modifications.

Methods

A pre-assembled propane flamer unit (Thermal Weed Control Systems, Inc.) was used as in 1994. In 1995, two major modifications were made on the unit. First, two additional liquid burners were added, making a total of ten burners. Second, burners were paired, five pairs total, and each pair was placed within a shield or hood. The shields forced the heat downward and prevented heat and flame from escaping upward. The burners, shields, 100 gallon tank and associated gas

hoses and pipes were mounted on a 3-point hitch. Each burner was capable of producing 500,000 BTU's, the same as in 1994.

The unit was field tested on May 5, 1995, at the U.S. Forest Service, Oconto River Seed Orchard (ORSO), located on the Nicolet National Forest in northeastern Wisconsin. A series of plots, 18 ft. X 40 ft. were burned. The tractor that pulled the flamer unit was run at two speeds, 0.75 and 1.20 mph, to generate two distinct levels of heat. The slower speed resulting in higher temperatures. In addition, two plots were sprayed with a fine mist of water to investigate how surface moisture affected heat production within cones.

Temperatures generated within cone beetle killed cones during treatment were recorded using a probe attached to a data recorder. The probe was inserted into a hole drilled into cones. The cones were then placed into the approximate center of each test plot. Two probes were used on some of the plots.

Following treatment, percent survival of cone beetles was calculated within each plot. A minimum of 40 cone beetle infested cones were collected from each plot, dissected and live and dead beetles recorded. Fifty cone beetle infested cones were collected immediately outside the treatment blocks. These cones were dissected and percent survival determined in order to obtain an estimate of beetle survival in unburned cones.

Results

Table 1 shows the percent of beetles surviving within cones following the various treatments. The probe and data recorder were apparently not functioning during run 1. Further, the cone temperature for run 2 (20 ^{0}C) is probably incorrect. Both runs 1 and 2 should have been very similar in internal cone temperatures to runs 7 and 8. This is based upon similar tractor speeds and similar fuels. The temperature probe(s) were functioning properly during run 3 and all subsequent trials.

Beetle survival in the unburned cones (Check in Table 1) was 89 percent. Beetle survival in runs 1, 2, 7 and 8 (tractor speed .75 mph) was very low, 0-3 percent survival. These results indicate that the treatment was very successful in generating the heat necessary to kill adult beetles within the cones at this tractor speed. The temperatures generated within those cones was 72-83 ^{0}C for treatments 7 and 8.

The tractor speed was increased during runs 3 and 4 to approximately 1.2 mph. This resulted in a decrease in internal cone temperatures by approximately 15-25 ^{0}C from the slower speed of 0.75 mph (Table 1). Some beetle survival was observed for runs 3 and 4, 10 and 6 percent, respectively.

The spraying of a light mist of water onto the cones and associated ground fuels, runs 5 and 6, resulted in significantly reduced internal

cone temperatures of 25-30 ^{0}C (Table 1). This reduction in temperature resulted in little beetle mortality occurring during those two runs.

DISCUSSION

The equipment modifications made between the 1994 trials and 1995 made a significant improvement in the efficacy of the treatment. At the slowest tractor speed of .75 mph the vast majority of beetles were killed following treatment. Only one of four runs had any surviving beetles within the treatment block (run 8, table 1). Speeding the tractor slightly to 1.2 mph reduced the efficacy of the treatment slightly. However, the survival of 10 percent of adult beetles could be significant during some years, especially during low cone crop years. Treatments with the flamer should not be done following any rain or if dew is present. The presence of moisture on the fuels apparently has a significant effect on the treatment efficacy by reducing the heat generated within cones.

The propane flamer used in 1995 at the Oconto River Seed Orchard should be a viable treatment alternative for cone beetles to prescribed burning or insecticide application.

REFERENCES

Katovich, S. And W. Sery. 1995. Operation of a propane flamer for control of white pine cone beetles in a seed orchard. (In) Sixth Report National Steering Committee for Management of Seed, Cone, and Regeneration Insects, USDA For. Serv., Davis, Calif. FPM 95-11.

Miller, W. E. 1978. Use of prescribed burning in seed production areas to control red pine cone beetle. Environ. Entomol. 7:698-702.

Moyer, D. D. 1992. Fabrication and operation of a propane flamer for Colorado potato beetle control. Cornell Coop. Extension, 7 pp.

Wade, D. D., G. L. DeBarr, L. R. Barber and E. Manchester. 1989. Prescribed fire - a cost effective control of the white pine cone beetle. pp. 117-121. (In) Proceedings of the 10th conference on fire and forest meteorology, (eds.) D. C. Maciver, H. Auld and R. Whitewood, Ottawa, Canada, 471 pp.

Table 1. Mortality of white pine cone beetles observed at various temperatures generated by a propane flaming unit. Trials conducted on May 5, 1995, at the Oconto River Seed Orchard, Nicolet National Forest, Wisconsin.

Run #	Tractor Speed (Mph)	Internal Cone[1] Temperature °C	% Beetle Survival
1	0.75	??[2]	00
2	0.75	20	00
3	1.20	54	10
4	1.20	54 & 66[3]	06
5[4]	1.20	30 & 25[3]	80
6[4]	0.75	26 & 29[3]	85
7	0.75	72 & 83[3]	00
8	0.75	79 & 80[3]	03
Check	--	---	89

[1] Temperature probe was inserted into a cone beetle killed cone.

[2] Temperature probe inoperable, conditions similar to trials 7 and 8.

[3] Two temperature probes utilized.

[4] The ground fuels and associated cones were sprayed with a light mist of water immediately prior to treatment for runs 5 and 6.

Keith Windell, MTDC

Thermal Insect Control

Thermal Insect Control
(TA&S# 3E32P11)

FY 95 Progress Report

Keith Windell, MTDC Project Engineer
June 2, 1995

Beaver Creek Seed Orchard *(Corvallis, OR)*

This past year (about May 1st) the Beaver Creek Seed Orchard tested a modified flail chopper (now called the rolling hammer mill) made by the Rear's Manufacturing Company (Eugene, OR). They had to rent an 85 Hp tractor to make the 7 foot wide rolling hammer mill work correctly. The machine grinds up the orchard duff layer to a very fine size. The equipment was operated by Al Mikkelsen from the Foley Seed Orchard on the Willamette N.F. Those in attendance were Bill Randall (Siuslaw N.F.), Jim Rears Sr. and Jim Rears Jr. (both from Rear's Manufacturing). Testing of the equipment was just to check for function (in an operational setting it would take 3 passes per row). In a phone conversation with Bill Randall, he stated that the rolling hammer mill worked fine and that he thinks many of the detrimental insects would have been ground up [if they forgot to emerge April 1st]. Bill noted that the scheme of using the hammer mill in the winter or spring followed by burning doesn't work at the Beaver Creek Seed Orchard because it is too wet and new green grass grows in before the chopped grass has a chance to cure for burning. What they are planning next is to install some study sites in August or September. The treatments will be 1) hammer mill, 2) hammer mill & broadcast burn, and 3) control. They want the orchard floor treated before the insects start dropping out of the trees about December 1st. Insect traps will be put out by Dr. Tim Schowalter (Oregon State University) sometime before April 1st (typical emergence time of the midges).

The flail chopper tested at Beaver Creek was rejected for trials at the Oconto River Seed Orchard due to the high risk of damage to surface roots of the white pine seed trees. This is not a concern on the Beaver Creek site with its' Douglas-fir trees.

Oconto River Seed Orchard *(White Lake, WI)*

In FY 94 the Oconto River Seed Orchard tested a flamer built by Thermal Weed Control Systems, Inc. (Neillsville, WI). After the site was flamed, entomologist Steve Katovich from the Northeast Area S&PF (St. Paul, MN) examined the cones for insect mortality and found less than satisfactory results. This past winter MTDC financed Thermal Weed Control Systems, Inc. to retrofit the Oconto River flamer unit with five experimental hover burners (figure 1) the company was developing ($1500).

The modified equipment was tested on May 5th. MTDC sent Mike Huey (engineering technician) to monitor the internal temperature of the infected cones as the flamer passed over (study plan is located in the appendix). This was to be accomplished by boring a small hole down the longitudinal axis of the cone. A K-type thermocouple wire (Omega, w/ Nextel® sheathing) was then inserted and the hole sealed with welders paste. Data was recorded with a Campbell's Scientific CR10 data logger. The tractor speed was varied. The wire was protected from the tractor wheels with metal pipe. Cones were not abundant enough to warrant a full scale operation. In fact cones had to be consolidated in a common area so that two orchard rows could be burned.

Figure 1. Experimental hover burners.

The maximum cone core temperatures were as follows: *[Graphs are in appendix]*

Trial #	Time	Max. Temp	Tractor Speed/RPM
1 [(a)]	-----	-----	.75mph/1100rpm (1st gear, low range).
2[(b)]	0940	20.9C	.75mph/1100rpm (1st gear, low range).
3 [(c)]	0958	54C	1.2 mph/1100rpm (2nd gear, low range).
4 [(d)]	1019	55.4C, 66.9C *(two probes)*	1.2 mph/1100rpm (2nd gear, low range).
5 (area was wet down w/ fire hose - not much heat)	1034	26C, 29.6C *(two probes)*	1.2 mph/1100rpm (2nd gear, low range).
6 (another wet down)	1041	26.5C, 29.5C *(two probes)*	.75mph/1100rpm (1st gear, low range).
7 [(e)]	1051	71.3C, 83.2C *(two probes)*	.75mph/1100rpm (1st gear, low range).
8 [(f)]	1101	78.7C, 80.4C *(two probes)*	.75mph/1100rpm (1st gear, low range).

**** A stationary flame check generated 556C.***

(a) No temperature data..

(b) Another temperature peak of 21.7C appears at 0949. The technician had no clip board record of this event.

(c) The electronic data were not saved. The time and temperature data were observed and recorded from the real time monitor during the test.

(d) In trial #4 one of the thermocouples indicated ≥50C for 64 seconds and the other for 135 seconds.

(e) In trial #7 one of the thermocouples indicated ≥50C for 112 seconds and the other for 156 seconds.

(f) In trial #8 one of the thermocouples indicated ≥50C for 130 seconds and the other for 138 seconds.

The lethal larvae temperature suggested by Dale Wade (SRS, Macon, GA) of 120F (48.9C) was occasionally reached or exceeded by the flamer. Unfortunately, the study plan was not strictly adhered to so there is no way of knowing the exact moisture content of the cones tested. Some cones were exposed to the flamer more than once and some cones were drenched with a fire hose. The results do however, illustrate that the moisture content of the cone drastically alters the effectiveness of the flamer. Cones will be dissected by Steve Katovich to determine the efficacy of the hover burners.

It is speculated that this approach will not be totally satisfactory. In addition, there has been concern raised about potential safety problems with the flamer equipment. Therefore, a series of site visits was conducted to explore physically gathering the cones from the orchard floor and either grinding in place (without damaging tree roots), or carting the cones away for disposal. This effort is being undertaken in a project called "Non-Chemical Orchard Sanitation."

Discussion

It looks like the use of a flamer at the Beaver Creek Seed Orchard is not advisable. If they are successful at burning in the late summer/early winter period they will have no need for the flamer. It is more cost effective to broadcast burn than to use the flamer.

At this time it is not known by MTDC what the final insect counts were from the May 5th hover burner test at the Oconto River Seed Orchard. Final comments from Bill Sery and Steve Katovich need to come in before deciding the fate of the thermal seed and cone insect eradication approach (flamer). If they think that it is not working, the approach should be abandoned. It should be noted that there has been concern expressed about the use of the liquid propane equipment.

Recommendations for work in FY 96

1. If the flamer approach is recommended by Oconto River Seed Orchard - MTDC should prepare a tech-tip explaining the technique and equipment involved.
2. MTDC should continue to monitor the rolling hammer mill/broadcast burn work at the Beaver Creek Seed Orchard (attend upcoming August/September 1995 test). MTDC should supply technical help as needed.
3. If the above techniques are not working they should be abandoned and other schemes tried (i.e. MTDC has purchased a steam generator for use on a soil sterilization project for the nurseries. Possibly the steam generator could be modified to work at Beaver Creek and/or Oconto River. Before this approach is taken it should be kept in mind that the steam generator costs $20,000 before modifications. This is two to four times the initial capital investment found acceptable by orchard managers in a recent MTDC orchard survey - see appendix).

APPENDIX

Temperature Data Collection
at the
Oconto River Seed Orchard

May 5, 1995

Background

Forest Pest Management is interested in eradication methods for seed and cone pests in seed orchards. The MTDC project "Thermal Insect Control" (503211), was initiated at a time when work at two different seed orchards was already underway. The basic concept suggested and pursued by the Oconto River Seed Orchard (WI) and the Beaver Creek Seed Orchard (OR) was to adapt agricultural weed burning equipment (LP gas fired) or "flamer" to burn their orchards when environmental conditions would not permit a typical control burn (i.e. too wet). The entomologists working with these orchards (Steve Katovich, FPM, St. Paul, MN, and Dr. Tim Schowalter, Oregon State University) had estimates of flame temperatures and duration necessary to kill the orchard's targeted pest. Before MTDC became involved they tested the effectiveness of the flamer treatment by dissecting treated cones and checking insect mortality. This method is not conclusive because beetles are not always present in the cones dissected and sources for insect mortality are numerous. A time temperature profile of the event is an easily reproducible way of checking the burner concept. It can also be used to compare different burning units or configurations. This study plan will focus on upcoming data collection at the Oconto River Seed Orchard (ORSO).

At ORSO the major seed and cone pests are the white pine cone beetle and the cone moth (eucosma). The flamer targets the cone beetle. The cone beetle overwinters in the white pine cones on the orchard floor. ORSO is attempting to kill the beetle larvae before they emerge in early May and fly up into the tops of the tree to start the cycle again. Although entomologists think they know what internal cone temperatures must be reached to cause insect mortality they do not have the equipment to measure the internal cone temperature.

MTDC will go to the seed orchard during an operational burn using the flamer. The flamer being used this year is a modification of the one tested last year (MTDC paid for the modification). It has special prototype burners referred to as hover burners. Dead white pine cones will be instrumented with a high temperature thermocouple and temperature inside the cones will be monitored as the flamer passes over. The event will need to be duplicated as many times as possible. Tractor speed needs to be varied over an operational range. It is anticipated that slower tractor speeds, and therefore flamer speeds, will produce higher internal temperatures. This data will be brought back to MTDC and graphed to display a time temperature history of the event.

Objective

To monitor and record the temperature history inside an immature white pine cone as it is exposed to a transient heat source. The heat source will be the open flame from an agricultural weed burner (flamer) fitted with experimental "hover burners" that is pulled by a farm tractor.

Methods

Task #1

1. Temperature data will be collected using a "K" type thermocouple wire encased in a Nextel sheathing (Omega brand).
2. Data will be collected and stored in a Campbell Scientific CR-10 Data Logger.

3. The cone being studied will need to have a 3/8" hole bored half way down the axis of the cone. A battery powered drill will assist in preparing the cone on site. It may be easier to saw off a flat surface on one end of the cone first before attempting to drill the hole. A small saw or knife will work.
4. Shove the thermocouple into the cavity drilled in the cone.
5. Seal the remaining gap with welders paste.
6. Cone needs to be placed in path of flamer. Make sure to flag the position of the cone so the tractor operator can avoid running over the cone with their tires. Run thermocouple wire 90 degrees out from the path of the tractor. Protect the wire by placing inside a 1/2" diameter pipe that is wide enough for tractor wheels to ride on top of instead of on the wire (this is necessary because Nextel becomes very brittle upon heating). Restrain pipe from rolling by blocking between pieces of lumber or pegging in place with "U" wire staples. An alternative to the pipe would be to dig a shallow trench and bury the wire. Ask the Orchard Manager (Bill Sery) if this is OK with him before you do it. He may be concerned about the tree roots.
7. Collect temperature data as flamer passes over. Monitor temperature in real time mode to see if things look reasonable. Start data collection before passage begins and continue to record for 15 minutes after (or until temperature readings level off significantly). The highest temperature achieved as well as temperature duration information will be obtained. Sampling rate should be set for every second. Data recorded must reference date and time.
8. Make sure you know the gear and RPM the tractor is operating at. Record this information along with the date and time.
9. Allow the thermocouple to cool down before conducting another replication. Alternating the use of the two thermocouples may be a consideration. Dipping in cool water may be a possibility. Use caution when handling the hot thermocouple wire and steel pipe.
10. A new cone must be used for each flamer run.
11. Data should be downloaded from CR-10 to a 3 1/2" floppy disk.
12. The burn will last several days so collect for more than one day if possible. If more than one unit is burned take samples in each.

Task #2

Monitor the surface temperature under the flamer as it passes. The setup will be the same as with the cone monitoring except the thermocouple will be laying on the ground. Again it is important to protect the wire with piping or trenches.

Task #3

Instrument a cone and monitor the temperature inside the cone under a stationary flamer. Monitor for 10 minutes or until the cone is incinerated. This should give a good idea of the insulating value of the cone and some realistic times for the internal cone temperature to reach higher values. Perform this task after you have collected at least 7 of the cone tests, and 3 of the surface temperature tests have been conducted. This should be done because of the increased chance of destroying the thermocouple under the intense stationary flamer heat.

Safety Concerns

According to Dave Gasvoda the Nextel sheathing stiffens after exposure to heat. It has the consistency of fiberglass insulation and small strands may cause splinters. For this reason, wear gloves when handling the thermocouple wire near the burned end.

When moving the steel pipe used to protect the thermocouple use caution as it will remain hot long after the flame source is gone. Again gloves should be worn.

Tools to Bring

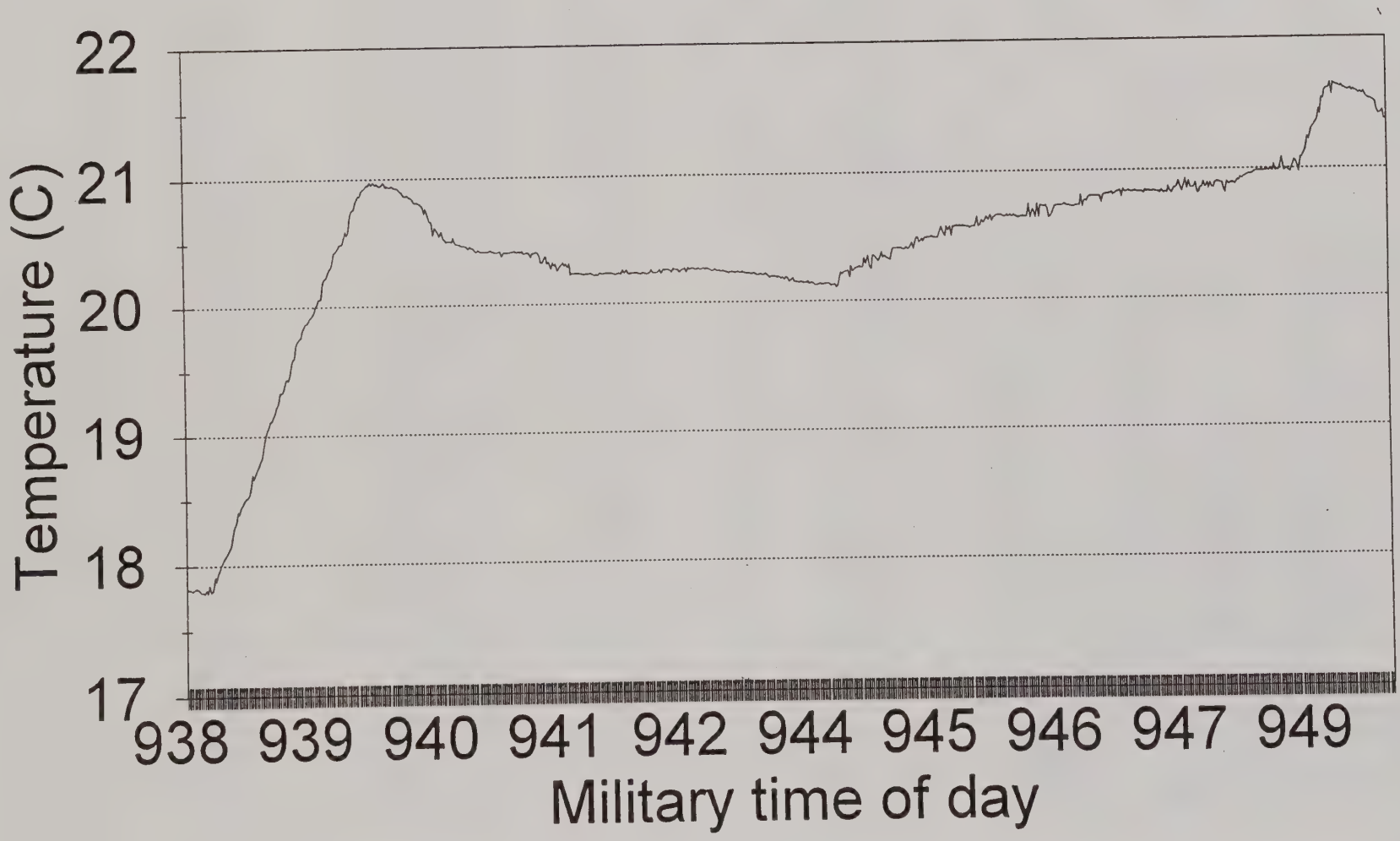
- Thermocouples
- CR-10 Unit
- Recharging unit for CR-10 battery
- Lap top computer to down load and store data logger information
- Recharging unit for laptop batteries
- 3-1/2" floppy disks
- Battery powered drill with proper sized bit
- Small saw (for squaring ends of cones)
- Welders paste
- "U" shaped pins (for restraining steel pipe from rolling)
- Clip board and paper to record tractor gear/RPM information
- Nomex® safety clothing
- Hardhat
- Gloves
- Boots that you don't mind wearing in burning areas

Results

The raw data collected at the seed orchard will be converted into time temperature graphs back at the office. The graphs should indicate whether the hover burner concept is a viable approach for the eradication of white pine cone beetles.

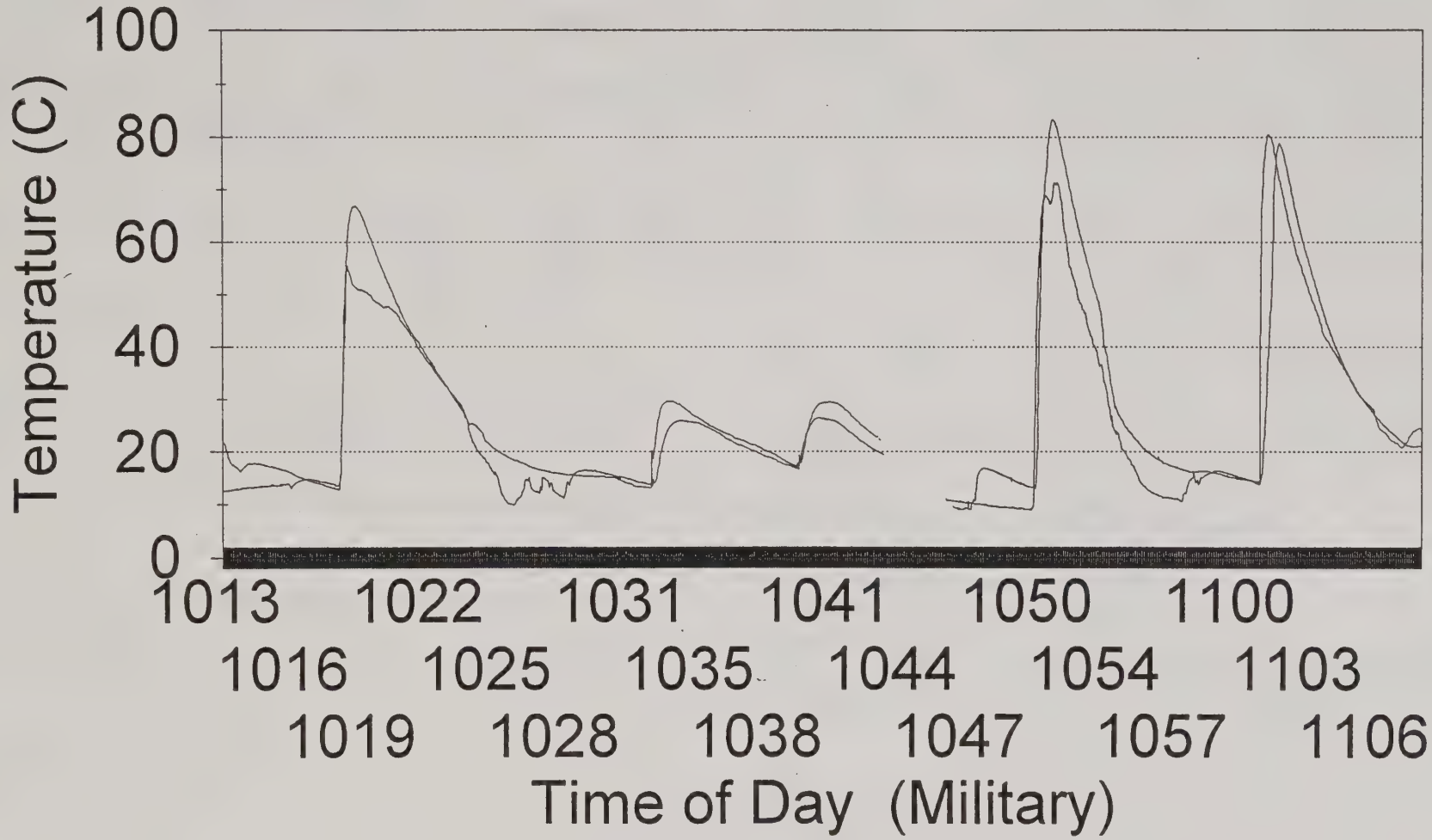
Oconto River Seed Orchard

Trial #2 5/5/95



Oconto River Seed Orchard

Data for Trials #4 - #8 5/5/95



SEED & CONE INSECT SURVEY RESULTS
FOR
SEED ORCHARDS

The purpose of this survey was for the Missoula Technology & Development Center (MTDC) to obtain information on the extent of damage caused by seed and cone insects in seed tree orchards and on the current technology used to control them. The information will be used to set design and evaluation criteria for any equipment or concept which may be developed as an alternative to the use of sprayed chemicals.

Total number of responses: 21 (3 of the responses indicated their orchard was new or mothballed and did not fill out survey)

Tallied responses broken down by agency: 10 Federal orchards
2 State orchards
6 Private orchards

Tallied responses broken down by state:

8 OR	1 ID
3 WA	1 NC
2 CA	1 MS
1 AR	1 WI

Current seed and cone pest status: *(Blank cells indicate no response)*

Orchard	Insect	Tree species attacked	Damage	Current control treatment(s)	Est. treatment efficacy
Oconto River	1. Conophthorus coniperda 2. Eucosma toculinana 3. Misc. insects in red pine - no work in this area yet.	Eastern white pine	1. Aborts immature cones. 2. Bores through cones & destroys seeds.	Asana used in heavy crop years. Propane burner being developed. Trap line run each year to identify insects & pheromones.	Asana shows visual (subjective) improvement over no treatment. 80% beetle mortality with burner. Inconsistent results with burner. Similar results with past prescribed burns.
Beaver Creek	1. Cone scale midge 2. Seed chalcid	Douglas-fir (DF)		No std. insect control method	

	3. Cone weevil			used. Ground sprayers with Guthion last used in 1980. Prototype burner is being tested.	
Westfir/Buckhead	1. Chalcid 2. Midge	DF	Young orchards - no seed production yet.	Aerial applied chemicals will probably be used.	Very effective. Not sure if it will continue with use over time.
Beech Creek	Cone beetle	Eastern white pine	Attacks second year conelet.	Prescribed burn.	10% loss of crop.
Quachita	1. Tip moth 2. Cone worm 3. Seed bug	[Southern pines]		Nothing. Used aerial spraying of Guthion until 1986.	Spray treatments were very effective.
Erambert	1. Cone worms 2. Seed bugs	Slash, longleaf, loblolly and shortleaf pines		Nothing at present. Used Guthion, Asana, Foray, and Pydrin in past.	Chemicals saved 75%-80% of crop (maybe more depending on the year).
Happy Camp Outplant Site	1. Conophthorus lambertiana 2. Dioryctria abietella 3. Eucosma sonomana 4. Ryacionia zozana	1. Sugar pine 2. DF, Ponderosa pine (PP) 3. Western pine 4. PP	1. Aborted cones, seed losses. 2. DF cones, PP graphs, pine rust cankers. 3. Leader and cone-bearing shoot damage. 4. Shoot & bud damage, pollen branches.	Cloth rice sacks are applied on selected conelets to exclude cone beetles. Old cones are picked up and burned annually.	If done in Jan. or Feb., often even before the snow melts, protection is good.
Genetic Resource Center - Chico	1. Dioryctria spp. 2. Leptoglossus occidentalis	1. DF, PP, Afghanistan pine 2. PP		Pheromone traps for background surveys. Seed damage assessments.	Yet to be determined.
Provolt	1. Dioryctria abietivorella 2. Barbara colfaxiana	DF	1&2. Larval mining of seed and cones,	Cone sanitation. (no operational	Even with sanitation, insect damage has been heavy in the

	3. Contarinia oregonensis 4. Megastigmus spermatrophus		premature ripening of cones. 3. Cementing of seed to scales, will not separate. 4. Larval mining of seed contents.	cone production yet). In 1995 bat houses and bird boxes will be installed (to encourage biological control).	small number of scattered cones produced the past three years. Estimate over 25% of seed crop is lost yearly.
Sprague	1. Leptoglossus occidentalis 2. Dioryctria abietivorella 3. Eucosma spp.	1 - 3. Sugar pine. 2. PP	1. Majority of damage, individual seeds. 2 - 3. Mining of seed & cone. Overall little damage in PP. Orchard not producing many PP cones yet.	Chemical pesticide spray - Asana XL - two ground based sprays/season (June & July) to cone bearing sugar pine trees. Thorough sanitation of all orchard units - removal of all unpicked cones from trees & ground.	The chemical treatments & sanitation are very effective. Loss is estimated at 3% - 10% per cone year for sugar pine seed.
Schroeder	1. Gall midge 2. Seed bug 3. Cone worm			Problems have been light to date. Asana has been used (ground spray) in attempt to control gall midge.	Hard to judge since losses have been light. Well under 5%.
Quinault	Insect damage low. Orchard 10 years old. Cone production just beginning.			Sanitize orchard by removing all cones.	Fine so far.
Whidby (Plum Creek)	1. Dioryctria (coneworm) 2. Leptoglossus (seed bug) 3. Contarinia washingtonensis (cone scale midge)	1 - 4. DF 2. Western white pine (WWP)		Orchard sanitation, attempt to find eggs and estimate potential in the spring.	New orchard so no baseline formed yet. Seeds not extracted yet so do not have complete results. Estimate 50-75% loss this year.

	4. Contarinia oregonensis (cone gall midge)			1993 selective spraying.	
Cherrylane	1. Dioryctria sp. (coneworm) 2. Eucosma sp. (coneborer) 3. Leptoglossus occidentalis (western conifer seed bug)	1. DF, WWP 2 - 3. WWP	1. Bore into cones & graft unions on DF, bore into cones on WWP. 2. Bores into cones on WWP. 3. WWP, causes conelet abortion and directly feed on seed in mature cones.	Rotate between Asana XL and Pounce insecticides aerially applied in mid-April to control adult moths of Dioryctria and Eucosma (1). Same 2 insecticides aerially applied to seedbug in early July. Their presence is visually determined.	Very effective if timed right and no rain hits, reduces damage to approximately 5% or less.
Medford	1. Barbara (midge) 2. Dioryctria (chalcid) 3. Seed bug	DF	We have not harvested a production crop yet.	Heat sum model (based on 2 year study) used to accurately predict optimum spray window for both Barbara and Dioryctria at Medford.	Two properly timed sprays will reduce cone damage from Barbara and Dioryctria from 60% to 4%.
Weyerhaeuser Orchard Program (Centralia)	1. Gall midge 2. Chalcid 3. Coneworm 4. Cone moth 5. Seedbug 6. Gouty pitch midge	1 - 5. DF 3 & 6. PP		DF: pesticides. PP: Burning on Gouty.	Pesticides - variable but generally good (however environmentally unacceptable - need alternatives). Gouty ?
Weyerhaeuser Company (Turner)	1. Midge 2. Chalcid	DF	Cone and seed	Dimethoate (lost label in 1994). MSR (off	Heavy loss to crop from midge - we need to evaluate Asana via aircraft.

				market). Asana.	
Cottage Grove	1. Contavinid oregonensis 2. Megastigmus spermotraphus 3. Ceptoglossus occidentalis 4. Dioryctria	DF	3. Eat mature seed.	1. Dimethoate 1/2% hydraulic at conelet turnover. 2. --- 3. Pydrin if population is high. 4. ---	Usually very effective, unless wet weather lessens spray effectiveness, or insect populations are very high. Say 10-20% losses.

(1) Pheromone trapping has not given a good assessment of presence or absence of moths, i.e. traps may not catch anything but major damage may still occur.

Current pest control economics: *(Blank cells indicate no response)*

Orchard	Est. annual value of crop ($)	Est. annual cost of treatments ($)	Est. crop loss W/O treatments (%)
Oconto River	$40,000	Asana - labor costs plus $800 Propane - labor costs plus $300	95%
Beaver Creek			70% - 78%
Westfir/Buckhead	?	?	20% - 60%
Beech Creek	$75,000 (on a given crop when collection is needed)	$8,000 (on a given crop when collection is needed and if pesticides were used)	50%
Quachita	NA	NA	60%-90%
Erambert		$0	Varies from year to year.
Happy Camp Outplant Site	4,000 - 10,000 resistant seed/yr. plus test materials.	$70. (2 mandays climbing extra plus bags)	50%
Genetic Resource Center - Chico	$700,000 - $1,400,000	NA	DF 100% PP 50% AP 60%
Provolt		$300 - labor for sanitation	>25%
Sprague	$50,000	$3,000	5 - 80%. Ave. 25% sugar pine seed. Varies a lot from year to year.
Schroeder	$400,000	$2,000	5%
Quinault	NA	NA	NA

Whidby (Plum Creek)	NA	labor only.	unknown.
Cherrylane	$10,000	$3,000	50%
Medford	Projected: $500,000 (1996) - $2,300,000 (1999)	$16/acre	60+%
Weyerhaeuser Orchard Program (Centralia)	Mega bunch		80%
Weyerhaeuser Company (Turner)	$250,000+	$4,500	>50%
Cottage Grove	$50,000	$1,000	60%

Equipment design considerations: *(Blank cells indicate no response)*

Orchard	Acceptable initial equipment investment ($)	Acceptable annual treatment cost ($)	Required reduction in pre-treatment insect population levels (1)	Current or future treatment constrains
Oconto River	$5,000 - $10,000	$5,000	5% of original population levels	Pesticides are administratively difficult to use. No major smoke constraints. Burning is administratively difficult due to need to write burn plans.
Beaver Creek	None - we have 15-20 years of seed in storage.	If treatment cost is less than value of seed lost it is effective.		Pesticides can be a problem - but have been used.
Westfir/Buckhead	$5,000 - $15,000	$2,000 - $6,000		Use of pesticides will be a problem in the future. Smoke could become a problem.
Beech Creek	$0 (at this time)	$0 (at this time. No seed needed)	?	No.
Quachita				I doubt if we could get an EA signed for aerial spray with pesticides at this time.
Erambert		Varies with budgets and seed needs.		Pending final EIS.

Happy Camp Outplant Site	Minimal to none.	Minimal to none.		Vinyl drip lines are used to water most of our orchard. Polyester mulch mats are used on some plantings.
Genetic Resource Center - Chico	?	?	?	TES habitat, strict (but workable) pollution control, no aerial spraying.
Provolt	$10,000	$3,000 - $5,000	Not known. Est. 10-20%	Social objections to chemical use would severely restrict or prevent the practical use of chemicals. Some smoke restrictions exist.
Sprague	$10,000	$3,000 - $5,000	<10% survival	Social objections to chemical use would severely restrict or prevent the practical use of chemicals. Some smoke restrictions exist.
Schroeder	$10,000 - $15,000	$8,000 - $15,000 (2-5% of crop value)	Not known	None.
Quinault	$1,000 - $2,000	$1,000	Unknown	None yet but pesticides always touchy.
Whidby (Plum Creek)	$9,000	$5,000	Unknown.	Neighbors on 3 sides of orchard.
Cherrylane	$0 (until overwintering habits are further investigated).	$5,000 approx.	5% or less for all 3 insects is my guess and we obtain that with insecticides.	No constrains but I'm not sure how well our low ground cover would burn.
Medford	Crop value will probably level out at $3,000,000. We will spend an appropriate amount.	As much as is needed and as little as possible.	Don't know.	Our ability to spray is impacted by public roads and neighboring houses. The use of implant technology or ground directed sprays in area boarding roads or adjacent to houses would be helpful.
Weyerhaeuser Orchard Program (Centralia)	A fair amount.			
Weyerhaeuser Company (Turner)	$70,000 to date	1 to 2% crop value of that year.		Unknown.
Cottage Grove	$5,000	$2,000	?	No. Propane burning OK. Broadcast in doubt - smoke mgt.

(1) - Threshold in % of pretreatment population levels to eliminate population from rebuilding in the same season.

Orchards which may be able to utilize flammer technology for pest control:

- Oconto River (for white pine cone beetle)
- Beaver Creek
- Westfir/Buckhead
- Genetic Resource Center - Chico (unknown at this time)
- Schroeder
- Quinault (unknown)
- Whidby (Plum Creek) (unknown)
- Cherrylane (unknown)
- Medford
- Weyerhaeuser Orchard Program (Centralia)
- Weyerhaeuser Company (Turner)
- Cottage Grove

Comments:

- Consider destroying one year's crop in attempt to lower insect population.
- Cut (eliminate) ground cover with flail mower (rolling hammer mill).
- Our white pine has sustained some root damage from the burning due to the shallow root system. Repeated burns will also kill out the fescue ground cover.
- More data on low-tech stuff - cone sanitation studies, burning in relation to irrigation setups (a big concern in the west), controlling fire around high value trees, effects of fire on mycorhizal associates, how about bug vacuums used when a specific flight can be predicted by monitoring? Are there cover crops that are antagonistic to overwintering soil residing pests.
- Alarm pheromone (when/if identified) dispersal systems, pheromone traps, non-phytotoxic chemical/injection systems.
- In 1995 an Eagle Scout will build and install bat houses throughout the orchard [Provolt] to attract bat populations for some expected control of cone and seed insects when the orchard produces cones in future years. The major insect pest adults are dusk and night flying moths which would be prey for bats. This control method is socially acceptable in the area, and the control is at best expected to reduce insect populations to and acceptable level. (note: The Sprague orchard will be installing bat houses & bird boxes in 1995).
- Have you considered altering the habitat? Burning in the fall when fuels are dryer, may not get the subject pest, but it could limit their survival by eliminating the overwintering habitat.
- If we could obtain a system that would insure protection from damaging levels of bugs and avoid pesticides we would be very interested.
- Cone removal from the site is very important for reducing population buildups.
- Stem injection research should be a high priority. The use of crop thinners to remove unwanted or unharvestable cone (in the flower stage) has been successfully used at Weyerhaeuser's Medford orchard. Work needs to be done on insect life cycle modeling and population sampling techniques for pest and beneficials to support IPM strategies.
- ... a field burner that would control the gall midge would be very helpful. I believe it will work.
- Abort unwanted cones at flowering. Flight trapping - identification for midge (adult) control.

- Would consider burning duff with propane for chalcid and midge on 1) non-forest orchard sites only (reinvasion), 2) no carryover of old cone crop in trees, & 3) clean (no slash) orchard only - root damage? Systemic injection of heavy-flowering trees only? Has use of tree shaker in removal of all cones (sanitation) proven cost-effective?
- I [Nancy Rappaport] developed an arboreal sprinkler with extensive help from MTDC (Diane Herzberg) that gave good insecticide coverage to the upper crown. Jack Stein (PSW Station) is now continuing development along with Sandy Kegley (R-1).

Summary:

Based on the survey responses the primary tree species planted in the seed tree orchards are: Douglas - fir, Ponderosa pine, western white pine, eastern white pine, sugar pine, slash pine, longleaf pine, loblolly pine, shortleaf pine, and Afghanistan pine.

The cones and seeds are ravaged by a variety of insects including: midges, chalcids, weevils, cone beetles, tip moths, cone worms, seed bugs, coneborers, and cone moths.

Current control methods include ground and aerial applications of the following chemicals: Asana XL, Pounce, Pydrin, and Dimethoate (1/2% hydraulic). The Medford orchard has developed a heat sum model to accurately predict the optimum spray window for their pests. Non-chemical methods include: prescribed burning, cone sanitation, exclusion of cone beetles from selected conelets by the use of cloth rice sacks, removal of unwanted or unharvestable cones (in the flowering stage), and prototype flammers and hammer mills. Some units are planning biological control by installing bat houses and bird boxes. Effectiveness of these treatments range from almost 100% insect mortality to 50%.

The estimated annual value of crop ranged from $10,000 to $1,400,000. The Medford orchard projected their crop value to be $2,300,000 by the year 1999. Estimated annual cost of treatments ranged from $0 to $8,000. Estimated crop loss without treatments ranged from 5% to 100%. The acceptable initial equipment investment ranged from $0 to $15,000 ($6,100 avg.). Acceptable annual treatment cost ranged from $0 to $15,000 ($4,400 avg.).

Most orchards did not know how low insect populations must be reduced to keep them from recovering that same season. It was mentioned that some of the cone and seed insects are coming from off site locations each year.

Current or future treatment constraints included difficulty in the use of pesticides (administrative as well as poor public image), drift spray concerns, and smoke management.

Orchards which rejected the use of flammer technology (and prescribed fire) listed concerns about pitchy cankers increasing risk of upward fire movement, young trees, above ground plastic irrigation systems, and plastic mulches in the orchard.

Keith Windell, MTDC

Non-Chemical
Orchard Sanitation

Non-Chemical Orchard Sanitation

(TA&S# 5E52P69)

FY 95 Progress Report

Keith Windell, MTDC Project Engineer
June 2, 1995

Introduction

The primary objective of the "Non-Chemical Orchard Sanitation" project is to develop alternative techniques to rid seed orchards of seed and cone insects without the use of pesticides. When the detrimental insects overwinter in the cones on the orchard floor, special opportunities to kill them present themselves. Possible approaches include gathering the cones from the orchard floor and either grinding in place (without damaging tree roots), or carting the cones away for disposal. A variation of this theme which should increase efficiency may be to windrow the material first. As part of the investigative phase of this project Keith Windell traveled to Chico, Linden, and Salida, California to observe nut harvesting equipment demonstrations. These demonstrations were conducted by factory personnel. Companies visited were Weiss/McNair (Chico), Ramacher (Linden), and Flory Industries (Salida). Other equipment demonstrated included sweepers used to windrow nuts and a flail mover. Evaluation of this type of equipment may be pursued at the Oconto River Seed Orchard (WI) if the flamer trials (with hover burners) which were conducted on May 5th under the "Thermal Insect Control" project (TA&S #3E32P11) are abandoned due to lack of efficacy or safety concerns.

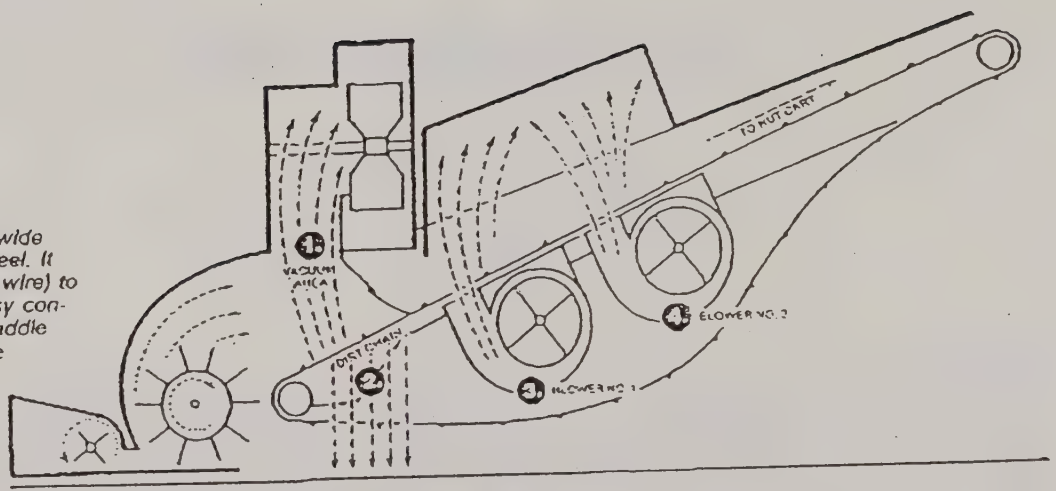
Site Visit to Weiss/McNair

Larry Demmer was the factory representative visited on May 23th. Larry explained that most orchards that use his nut harvesting equipment are table top flat with very little in the way of ruts or uneven ground. Just prior to harvest the orchard floor is closely mowed (many orchard floors are dirt so do not need this). The trees are then shaken. A sweeper windrows the nuts and a nut harvester picks up the windrow. A self dumping cart is usually pulled behind the harvester.

The harvester mechanically picks up the windrow with wire tines and/or rubber fingers (used in the chicken plucking industry). The heads are one of two types. The reel type pick up head is a drum (about 24 inches in diameter - figure 1) with several rows of parallel wire tines (with or without a slotted rubber backer) and or rubber fingers. The other type of pick-up head is called a belt (figure 2). This head also uses parallel rows of wire tines (with or without a slotted rubber backer) and or rubber fingers arranged on a small conveyor belt. Although the harvesters have huge fans they do not assist with the pick-up but are used for blowing or sucking the trash from the nuts on a series of conveyor belts. The newer designs only use the suction fans. It was speculated that these fans could grind up the cones and therefore do away with the need to transport away.

A model 8900 (tractor pulled, PTO driven) harvester with belt type pick-up head was tested (see appendix). The machine was owned by a local grower and was tested in the growers orchard. Numerous wooden dowel segments (1/2 inch and 3/4 inch diameter ranging from 1 inch to 1 1/2 inches long) were taken along to simulate the infected cones from the Oconto River Seed Orchard. California doesn't appreciate people bringing them more insect problems. Larry also brought some of his own pine cones. They were about 2 1/2 inches long and 1 1/2 inches in diameter. The harvester was set up with a dirt chain and conveyor chain for walnuts. The pick-up head can pick up a 48-inch wide windrow. Dirt chain and conveyor are both 48 inches wide. We were not able to tell how well it picked up the dowels because of the dowels falling through the large gaps in the dirt chain. Larry said a machine set up for almonds or pecans could easily deal with the dowels. The harvester was also tested with the pine cones. These cones

The 836H features a 36" wide by 24" diameter pick-up reel. It has 10 flites (8 rubber - 2 wire) to get all of the nuts in grassy conditions. The Front Feed Paddle Wheels allow for 48" wide windrows.



4-STAGE "AIR-VAC" CLEANING SYSTEM

■ STAGE 1:

The powerful, high volume vacuum system with longer suspension fall allows for maximum trash separation.

■ STAGE 2:

Assorted elevator dirt chain sizes permit gravity separation of heavy dirt, pea size gravel and stones.

■ STAGES 3 & 4:

Two high velocity, adjustable blowers deliver a one-two punch in cleaning out any remaining residues to assure you the cleanest crop possible.

Figure 1. Harvester with reel type pick-up head

Up front single vacuum fan allows for direct drive and a long gravity nut separation chamber. The longer gravity separation means more effective separation of leaves, trash and sticks for cleaner, more profitable harvesting.

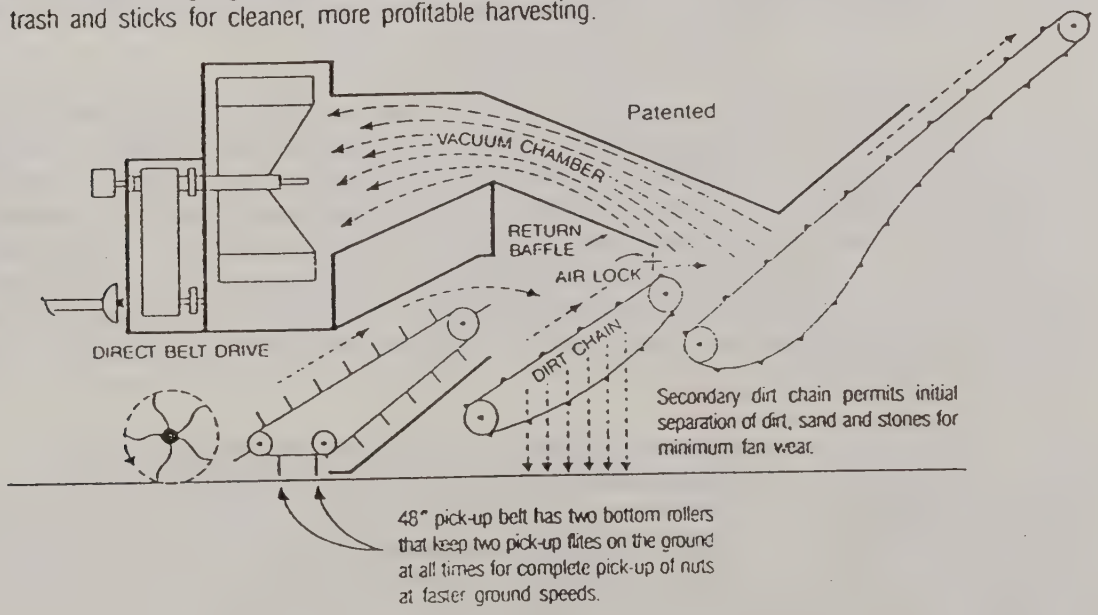


Figure 2. Harvester with belt type pick-up head

were picked up and deposited into the trailing cart. It was noted that the fan did not create enough suction to pull in the cones and grind them up. To test the idea of using the paddle fan for grinding several cones were intentionally thrown into the fan. The results were not impressive. The fan would have to be modified or this approach would not be successful. The literature calls for a 55 hp tractor so the John Deere 2350 tractor at Oconto River is very marginal and may not be adequate. A new model 8900 costs $24,900 and a reconditioned model 8900 costs about $18,500.

Sweepers are available in two basic head designs - the auger (or reel) type (figure 3 or the tine bar (hayrake or side delivery) type (figure 4). Both of these designs utilize wire tines (with or without slotted rubber backers) and/or chicken pluckers. The auger head is a simpler, cheaper design but all three companies visited thought a tine bar head would be best for our application. The use of strictly wire tines was suggested. A self propelled diesel powered sweeper with tine bar (Model HSD108) was tested and did a good job of windrowing the dowels on flat ground. However, some of the dowels placed slightly below ground level were missed. They currently have a used model HS35 (pictured as HSD40 with gas engine option in appendix) for $11,500 and another for $14,500. Sweeper heads are also available in a tractor mount version. Unfortunately used tractor mount models are hard to come by. A new tractor mount unit with 9 1/2 foot wide tine bar costs $9,650.

The HSD108 and HS35 sweepers come with a rear mounted blower. The blower on the HSD108 is larger than on the HSD35. The blowers' purpose is to clear nuts from the base of the tree to speed up the windrowing task. When tested, the blower was able to move free standing dowels but not able to move the ones hidden under the grass layer (this may mean orchard must be mowed prior to sweeping). Blowers are also available with a 3-point hitch and PTO drive for mounting on the back of tractors. Their B-85 (tractor mount, PTO driven) unit costs $3,825.

A flail mower was also tested at the orchard. A PTO driven unit made by Virismo (Turlock, CA) equipped with scoop knifes (figure 5) was adjusted to 1 inch above the orchard floor. This was because we did not want any contact with the white pine tree roots. Larry thought these knifes would provide the best suction. The results were not that impressive - it could not even pick up all the cones let alone the dowels and the cones were not that finely chopped. I would not advise using this equipment.

Self dumping trailers were discussed with Larry. Evidently the state of the art trailer used by the nut folks is the Herbst rear dumping trailer (contact Dave Herbst 916-787-3460). It utilizes hydraulic cylinders that back the unit away from the overhanging harvester conveyor belt and lifts the trailer to dump up to 10 1/2 feet high. The 180 cubic foot unit is $6605 and the 235 cubic foot unit is $7205.

A couple of other pieces of equipment came into discussion during the course of the day. The John Deere dealer in Chico recommended using the John Deere model 16A Flail Chopper for our application (see appendix). In addition to sickle knifes to cut the grass the chopper creates its own wind stream by a flywheel mounted on the end of the flail shaft. This is used to cut green forage and toss it up into a trailer. Additional knives can be mounted in the flywheel to chop vegetation (or cones) finer. The lowest cutting height for the machine is 2 1/2 inches above the ground. Cutting width is 6 feet. The orchards 2350 John Deere tractor will be powerful enough to operate the chopper. If the cone is not chopped finely enough we can always attach a trailer and transport cones away for disposal. I think this machine warrants a closer look. I have contacted the John Deere dealer in Marion, WI (40 miles from the Oconto River Seed Orchard) and they are willing to do an equipment demonstration at the orchard - provided they have a demo model on hand when we want to view it. A new Model 16A is about $8100 and a used one runs about $3500 (they want an additional $200 to add the extra knives to the fly wheel).

Glenn Stanley (General Manager) and Bob Souza (R&D) thought we should investigate another company called NH Savage (Lampasas, TX) that makes native pecan harvesters (brochure in the appendix). They suggested their 8090 pecan harvester which is made for working on uneven sites. It has a 61 inch wide pick-up head with stout rubber fingers, two short conveyor belts, a blower, and built in self dumping bin. Current price for a new 8090 model is $13,135 FOB Lampasas, TX. Greg Collins (Sales) thought an

Figure 3. Sweeper with auger head

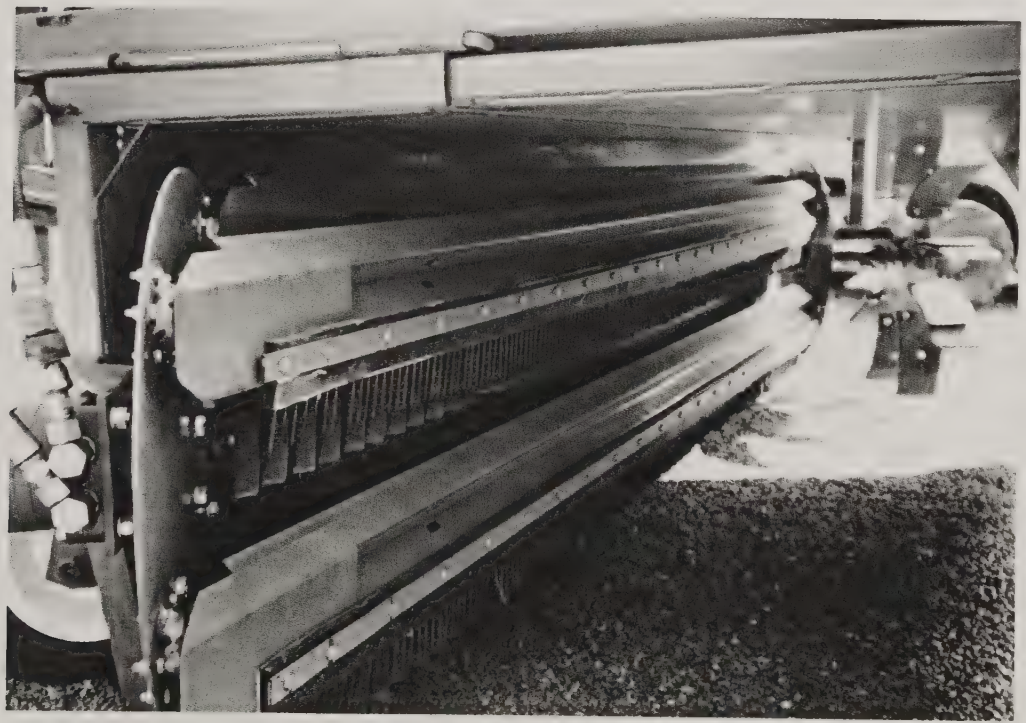


Figure 4. Sweeper with tine bar head

Figure 5. Flail mower/chopper with scoop knives

refurbished older unit they made called the Nut Hustler (similar to the 8090) could be had for $7,000 - $8,000. He said to check back with him in July or August to see if any were traded in. This machine warrants further consideration and a possible site visit.

Site Visit to Ramacher

Eldon Huff (General Manager) provide an equipment demonstration on May 24th. We looked at their 9620 model which is a self-propelled harvester with a reel type pick up head. This dirt and conveyor chain are sized to pick up almonds. Pick-up head width is 48 inches. Dirt chain and conveyor width are also 48 inches. This head was impressive and picked up all the dowels I laid out, even the ones I depressed in the ground. The suction fan did not significantly chop up the dowels. Eldon said the fan would have to be modified with shredding knifes if we wanted to destroy the cones. Ramacher's design looks like it could be modified so the dirt chain brings all the windrowed material directly into the fan. The 9520 is the tractor pulled PTO version of the 9620. If the 9520 is selected for use, Oconto Rivers 2350 John Deere would be marginal and a larger tractor may have to be rented. The cost of a used 9520 would be about $14,000 if available and the estimated cost of the modifications would be about $5000. Modifications needed would be:

1. Redirect air chamber.
2. Extend first conveyor belt (dirt chain).
3. Put shearing knives in fan (this is not a standard option and may require R&D work).
4. Put auger attachment on fan shaft.
5. Put all steel tines on reel type pick-up head (Longer than standard length).

We also viewed their 6400 series self-propelled sweeper. It was fitted with a tine bar head. The machine was owned by a private party and they would not adjust the tines down into the dirt. It appeared to have the potential to be very effective and I think it would work just fine when adjusted lower. Eldon recommended all tines and no rubber backers for our application. Ramacher's shop foreman even suggested longer than standard wires to help reach the cones in depressions. According to Eldon, a used self-propelled sweeper would cost about $14,000. A used tractor mount sweeper and blower would cost about $7,500 but he said he didn't have any and they were hard to come by. A new tractor mount sweeper and blower would cost about $13,000.

One interesting suggestion offered by Eldon was to do the flail chopping or harvesting in the fall when the vegetation was more brittle due to the cold weather (a possible drawback may be that the cones may also be frozen to the ground).

Site visit to Flory Industries

Marlin Flory and Tony Ringeisen provided an equipment demonstration on May 25th. We observed the Model 480 P.T.O. tractor pulled harvester (see appendix for brochure). It had a belt type pick-up head with wire tines and alternating slotted rubber backers. Pick-up head was 48 inches wide. Dirt chain and conveyor were also 48 inches wide. It did fine until the machine got on uneven ground. This may present a problem in the Oconto River Seed Orchard where tractor tire depressions are a common reality. When I informed Tony I worked for the Department of Agriculture and not the Department of Defense he recommended a used Model 210 (brochure in appendix) which is an older design that has the same pick-up head as the Model 480 P.T.O. Harverster. Major differences include suction and blower fans, pick-up head width of 48 inches, and a single conveyor belt. Material is funneled from 48 inches to 24 inches with a pair of augers. He said we could get a used unit (with fans and blowers removed) for about $5800 FOB Salida - if available. Tony said with fans our John Deere 2350 would be marginal - no problem with fans and blowers removed.

We also observed a Model 7650 self propelled sweeper with a tine bar head. This unit has a special twisting chassis which is intended to conform better to a working surface then the competitors models. Unit is powered by a 40 HP, 4 cylinder, Kabota diesel engine. It did fine. New Model 7650 sweepers cost

about $25,500. They also had an used older Model 6646-KD self-propelled sweeper for $11,000 FOB Salida. This unit has a 33 HP, 3 cylinder Kabota diesel engine, 6 1/2 foot wide tine bar head, and swivel chassis. Estimated FOB charges will run $2,000 - $2,500 one way. The most attractive part of working with this company is that if the equipment doesn't work they will take it back. We would only be out the $4,000-$5,000 round trip freight charges.

Cost Scenarios

Option	# of Passes (excluding perpendicular passes*)	Equipment	Estimated Cost (excluding shipping)
1. Flail chop/ leave debris on site.	4	Flail chopper (John Deere).	$8,100
2. Flail chop/Transport cones off site.	4	Flail chopper (John Deere), cart (Herbst).	$8100 + $7200=$15,300
3. Windrow & blow/Flail chop/Leave debris on site.	3 sweep/ 1 flail chop	Sweeper/blower (Used self-propelled Flory), flail chopper (John Deere).	$11000+$8100= $19,100
4. Windrow & blow/Flail chop/ Transport cones off site.	3 sweep/ 1 flail chop	Sweeper/blower (Used self-propelled Flory), flail chopper (John Deere), cart (Herbst).	$11000+$8100+$7200= $26,300
5. Harvester/ Transport cones off site.	6	Harvester (Used Flory), cart (Herbst).	$5800+$7200= $13,000
6. Harvester/ Transport cones off site.	5	Harvester (Savage)	$13,200
7. Windrow & blow/Harvester/ Transport cones off site.	3 sweep/ 1 Harvester	Sweeper/blower (Used self-propelled Flory), harvester (Flory), cart (Herbst).	$11000+$5800+$7200= $24,000
8. Modify harvester/Grind/Leave debris on site.	6	Modified harvester (Ramacher).	$19,000 ($26,200 if cart needed)
9. Windrow & blow/Modify harvester/Leave debris on site.	3 sweep/ 1 Harvester	Sweeper/blower (Used self-propelled Flory), modified harvester (Ramacher).	$11000+$19000= $30,000) ($37,200 if cart needed)

** Estimated number of passes based on 24-foot spacing between trees. Use of blowers may eliminate the use of cris-crossing back over the orchard.*

Discussion

A field survey was sent to the orchards last fiscal year which indicated they were willing to pay between $5,000 and $10,000 up front capital costs for equipment to replace the use of pesticides for seed and cone insect control. The agricultural flamer and flail chopper equipment tried in the past push these limits. The use of some of the proposed equipment in this progress report will definitely exceed these limits. Costs can be minimized by the practice of purchasing used equipment but that option is not always

available. Perhaps if the use of expensive sweepers, harvesters, and self dumping carts is perfected the concept will still be utilized if two or more orchards share the equipment. This of course implies that the window of opportunity (to destroy the inhabited cones) is large enough to allow for equipment sharing.

Recommendations for work in FY 96

1. Re-consider testing rolling hammer mill (Rear's Manufacturing) at the Oconto River Seed Orchard.
2. Schedule an equipment demonstration of the John Deere Model 16A Flail Chopper at the Oconto River Seed Orchard and purchase if successful.
3. If 16A picks up majority of cones, chops them fine enough, but is too slow - purchase a used Flory self-propelled sweeper with tine bar style head and blower.
4. If 16A Flail Chopper picks up majority of infected cones but does not chop cones fine enough purchase a Herbst cart and test the two together.
5. If 16A Flail Chopper unsuccessful take a site visit to investigate NH Savage native pecan harvester. If it looks better than Weiss/McNair, Ramacher, or Flory units purchase it for testing at Oconto River Seed Orchard.

APPENDIX

oducing
A Brand New
Separation Sy

SUPER·VAC

UNEQUALLED IN SIMPLICITY & RUGGEDNESS!

WEISS/McNAIR 8900 Series

Tractor Powered Nut Harvester

ALMONDS • WALNUTS

The new versatile WEISS/McNAIR 8900 is a high performance P.T.O. harvester designed with the greatest simplicity. It has no gearbox; just one belt, two sprockets and one short chain. Three hydraulic motors provide independent, variable power to the elevator, dirt chain and pick-up belt; thus, eliminating dangerous, high maintenance roller chains as well as minimizing the number of sprockets. The huge, single Super Vac suction fan with the unique trash separation chamber and the secondary dirt removal chain assure cleaner, faster harvesting at lower cost to you!

MINIMUM PARTS • FASTER, CLEANER HARVESTING AT LOWER COST • SAFER OPERATION WITH FEWER ROLLER CHAINS & SPROCKETS

A Leader In The Nut Harvesting Industry Since 1966

Qualified WEISS/McNAIR Welcomes your request for a demonstration. Write or call us direct:

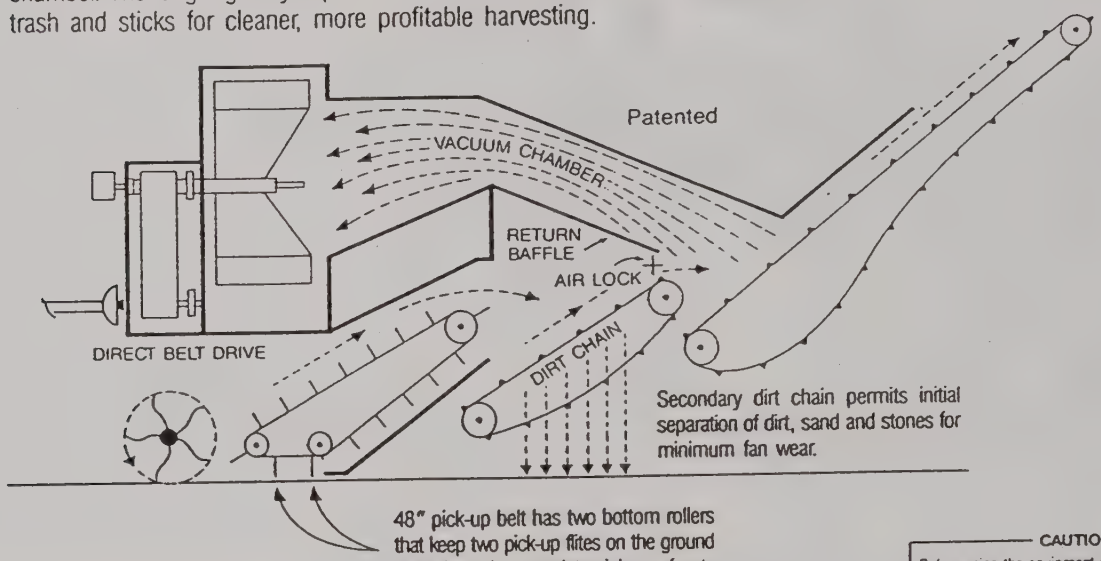
WEISS/McNAIR, INC., 531 Country Drive, Chico, CA 95928 (916) 891-6214

(see reverse side for specifications)

8900 Profit-Making Features

UNIQUE, SUPER VAC HIGH VOLUME SEPARATION SYSTEM

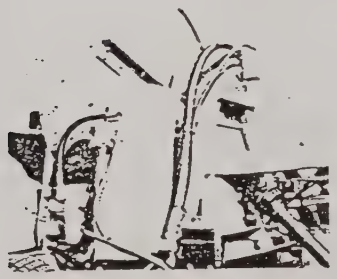
Up front single vacuum fan allows for direct drive and a long gravity nut separation chamber. The longer gravity separation means more effective separation of leaves, trash and sticks for cleaner, more profitable harvesting.



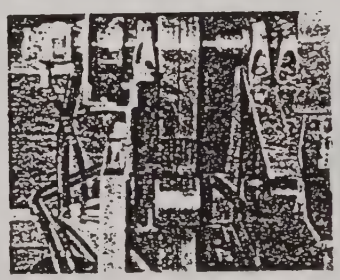
CAUTION

Before using the equipment described hereon, be sure to read the WARNINGS outlined in the Operating Manual and attached to the machine itself.

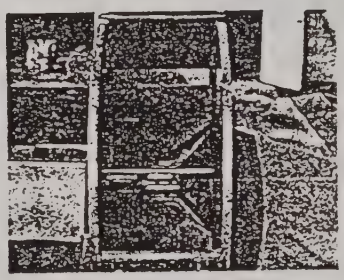
Designed For Maximum Performance At Less Cost!



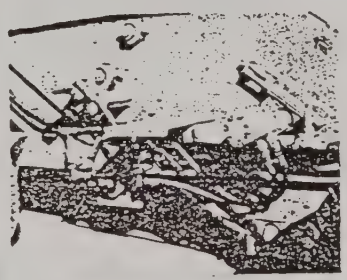
No hydraulic pressure is required from the tractor with 8900's independently built-in hydraulic system



6 groove power band belt provides direct power to the vaccuum impellers.



High volume Super Vac is fully protected with replaceable urethane liner and abrasive resistant, replaceable bolt-on blades.



Three hydraulic motors mean fewer dangerous, high maintenance chain and sprocket assemblies for safer operation and lower maintenance.

SPECIFICATIONS

- H.P. REQUIREMENT: minimum 55 H.P.
- P.T.O. SHAFT H.P. RATING: 35 Series
- TIRE SIZE: 26 x 12 x 12
- WHEEL BASE: 85"
- VACUUM FAN: 6 blade, abrasive resistant steel bolt-on
- DIRT CHAIN SIZE: Almond - ½" x ½"; Walnut - ⅝ x 1"; Walnut - Tube Chain; Filbert & Pecan - ½" x 1"
- PICK-UP TYPE: 48" belt with moulded cleats, with rakes backed by rubber fingers
- WINDROW CAPACITY: 6-48"
- DIRT CHAIN DRIVE: Hydraulic with speed control
- PICK-UP BELT DRIVE: Hydraulic with speed control
- HYDRAULIC SOURCE: Built into harvester
- OVERALL LENGTH: 18'
- HEIGHT: 81" WIDTH: 98"
- OPTIONS: Hydraulic lift; Elevator Extension; Front Pull Version

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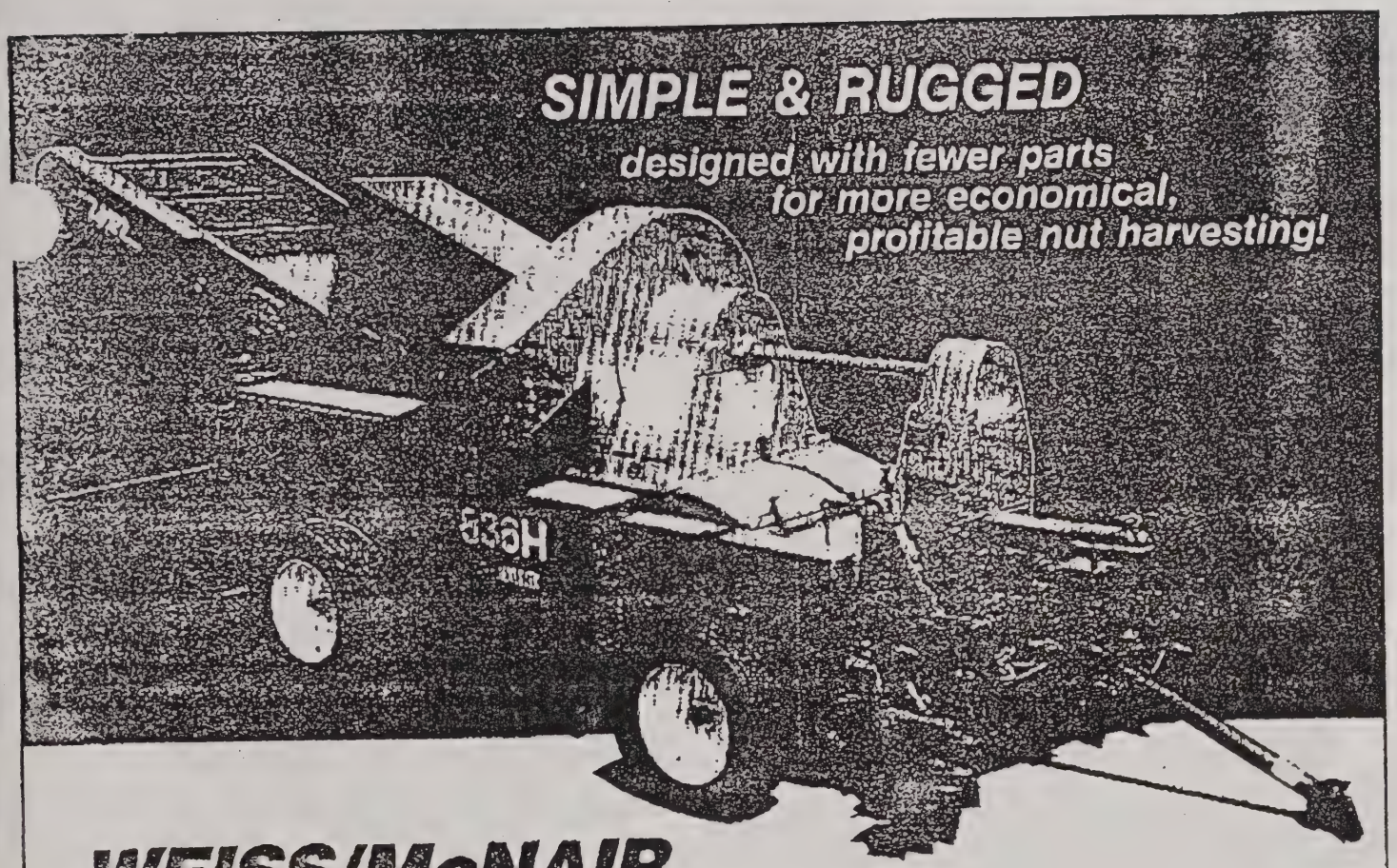
(916) 891-6214



SIMPLE & RUGGED

designed with fewer parts for more economical, profitable nut harvesting!

WEISS/McNAIR

836H

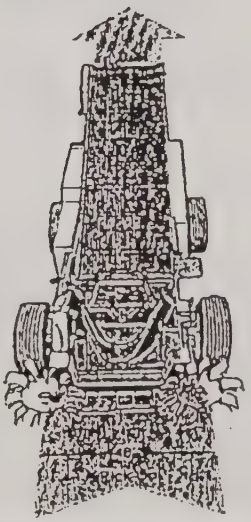
with a built-in hydraulic system

P.T.O. Pick-Up HARVESTER

Straight-thru 36" Elevator for faster WALNUT and ALMOND harvesting!

- MINIMUM PARTS MEAN LESS MAINTENANCE & PART REPLACEMENTS
- 4-STAGE "AIR-VAC" CLEANING SYSTEM FOR COMPLETE TRASH SEPARATION
- RUGGED DEPENDABILITY WITH EXTRA RE-INFORCEMENTS IN ALL WEAR AREAS
- BUILT-IN HYDRAULIC SYSTEM PERMITS VARIABLE SPEED CONTROL OF THE ELEVATOR CHAIN AND FRONT SWEEPERS

The new WEISS/McNAIR 836H Harvester reflects the new standard of design, strength and simplicity. It has minimum of parts yet has maximum harvesting efficiency. The time-proven 4-stage cleaning system separates trash rapidly, completely without destroying the nuts. This economical harvester is a true straight-thru 36" with unrestricted flow that permits faster ground speed. All moving parts are safely covered with easy to open, heavy gauge guards that are held in place with convenient rubber latches.



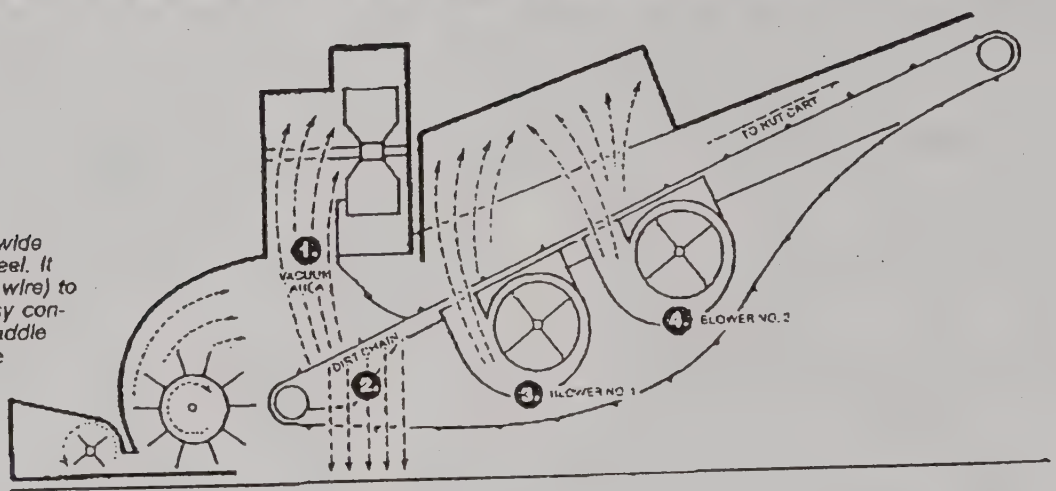
Qualified WEISS/McNAIR sales representatives welcome your request for a demonstration. Write or call us direct.

The Sign of Quality

WEISS/McNAIR, INC. 531 Country Drive, Chico, CA 95926 (916) 891-6214

836H PROFIT-MAKING FEATURES

The 836H features a 36" wide by 24" diameter pick-up reel. It has 10 flites (8 rubber - 2 wire) to get all of the nuts in grassy conditions. The Front Feed Paddle Wheels allow for 48" wide windrows.



4-STAGE "AIR-VAC" CLEANING SYSTEM

■ **STAGE 1:**

The powerful, high volume vaccuum system with longer suspension fall allows for maximum trash separation.

■ **STAGE 2:**

Assorted elevator dirt chain sizes permit gravity separation of heavy dirt, pea size gravel and stones.

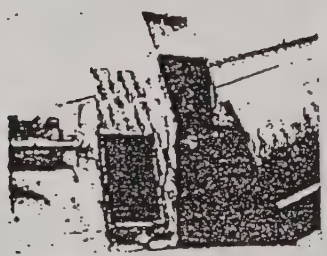
■ **STAGES 3 & 4:**

Two high velocity, adjustable blowers deliver a one-two punch in cleaning out any remaining residues to assure you the cleanest crop possible.

CAUTION

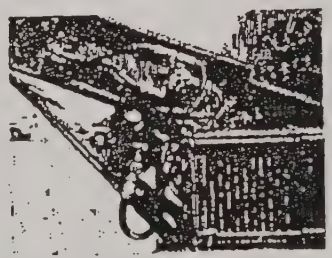
Before using the equipment described hereon, be sure to read the WARNINGS outlined in the Operating Manual and attached to the machine itself.

simply designed with fewer parts for lower maintenance and operating costs!



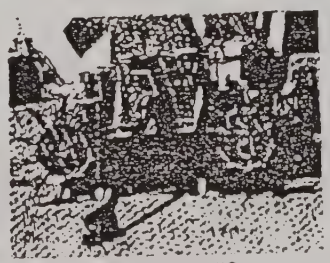
BIG MAC VACUUM

The high capacity vacuum for faster, cleaner removal of trash. Fully protected with tough, replaceable urethane liner and abrasive-resistant, replaceable bolt-on impeller blades. Hinged opening allows for easy access.



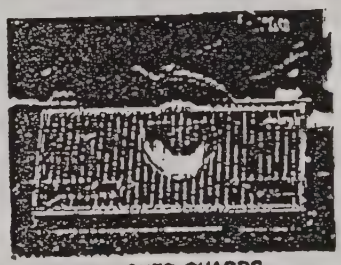
BUILT-IN HYDRAULIC SYSTEM

The elevator chain and front sweeper side paddles are hydraulically driven. Each has its own speed control for varying operating conditions.



SIDE FEEDER SWEEPERS

A real time-saver in preventing leaf pile-up in front of the side plates. It also brings scattered nuts along the windrow in to the chamber.



EASILY REMOVED GUARDS

All guards are held in place with convenient rubber latches for quick inspection and servicing.

SPECIFICATIONS

H.P. REQUIREMENTS:
Almond - minimum 45 H.P.
Walnut - minimum 55 H.P.
P.T.O. SHAFT H.P. RATING: 35 Series
GEAR BOX: Hub City 88 Series
TIRE SIZE: 27 x 9.50 x 15

VACUUM FAN: 6 blade, abrasive resistant steel bolt-on
DIRT CHAIN SIZES: Almond - ½" x ½"
Walnut - 1" x 1"
PICK-UP TYPE: 36" drum with 10 pick-up flites (8 rubber - 2 wire)
WINDROW CAPACITY: 48" with front feed paddle

ELEVATOR DRIVE: hydraulic with speed control
■ sprocket drive for walnuts
■ rubber covered rollers for almonds
OVERALL LENGTH: 18 feet
HEIGHT: 82 inches
OPTIONS: ■ Hydraulic Hitch
■ 25" Elevator Extension

For Parts & Service . . .
Call Your Authorized Dealer

A Leader In The Nut Harvesting Industry Since 1966

WEISS/McNAIR, INC., 531 Country Drive, Chico, CA 95928
(916) 891-6214

WEISS/McNAIR

(Diesel Powered)

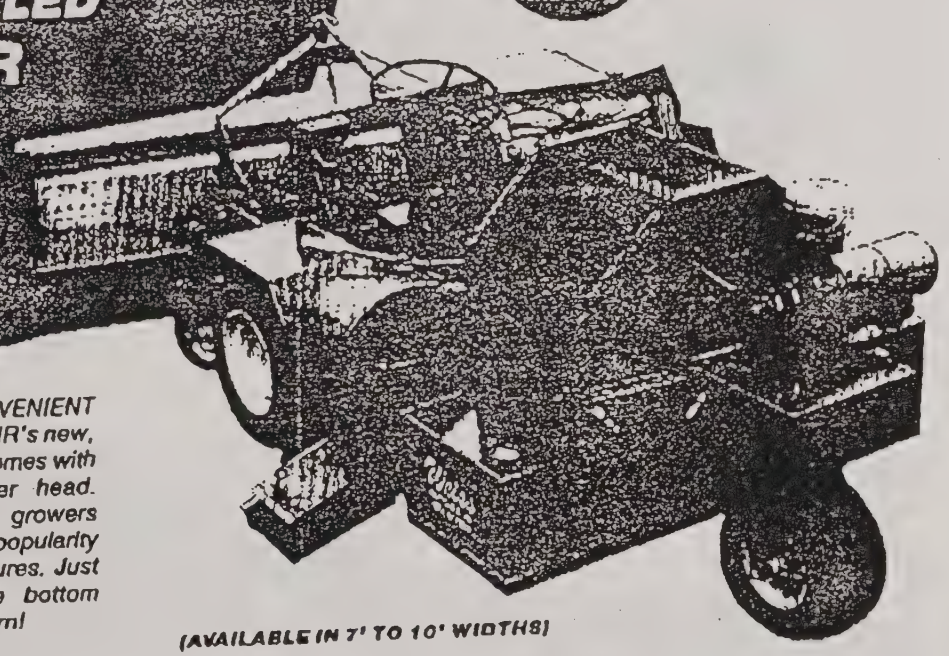
HSD40

SELF-PROPELLED SWEEPER

(HS35 Model with 35 H.P. Wisconsin Gasoline Engine also available)

YEAR-ROUND WORK HORSE FOR BIGGER YEAR-END PROFIT!

BEST VALUE in the Industry



FUNCTIONAL, VERSATILE AND CONVENIENT are the words that describe WEISS/McNAIR's new, rugged HSD40 self-propelled sweeper. It comes with either auger reel or tine bar sweeper head. Incorporating suggestions from many growers throughout the country, the HSD40's popularity reflect the merits of its many quality features. Just check for yourself, it's there on the bottom line. . . lower investment with a high return!

(AVAILABLE IN 7' TO 10' WIDTHS)

PROVEN MULTI-PURPOSE SWEEPER . . . DESIGNED TO EARN ITS KEEP!

■ **SUPER BLOWER:**
The HSD40's powerful blower is not mounted on the engine shaft. . . therefore runs only when it is needed.

■ **EXTRA RESERVE POWER:**
The powerful 40 H.P. DEUTZ diesel engine has maximum reserve power even with the blower engaged.

■ **BUILT-IN ENGINE PROTECTION:**
The engine is well protected with heavy-duty screen to keep out leaves and nuts.

■ **POWERED MANEUVERABILITY:**
Power steering and full hydrostatic drive provide instant control response for ease of operation. Tricycle (rear steering) design allows for short turns to avoid running over nuts.

■ **WELL DESIGNED:**
Up-front operator position provides excellent vision. The low profile design permits easy maneuverability to sweep under low-hanging limbs.

■ **VERSATILE:**
The sweeper head can be quickly disconnected and the power unit can be used for spraying, mowing, trenching, wood splitting, etc. The hydraulic system provides 8 G.P.M. at pressures up to 2,000 P.S.I.

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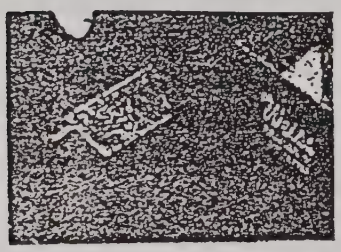
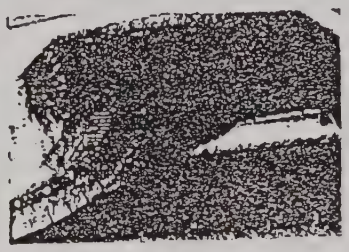
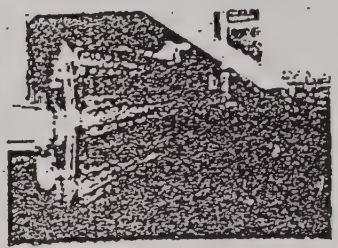
HSD40 PROFIT MAKING FEATURES



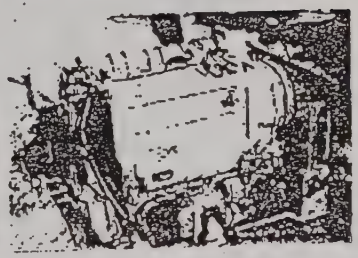
The HSD40 blower provides ample reserve air capacity for cleaner strip blowing in heavy trash conditions. The blower is not mounted on the engine shaft, therefore runs only when needed.



The auger head has alternate rubber and wire flites. All rubber reel flites are optional.

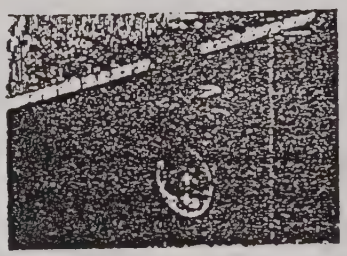


Variable speed, side delivery 5 or 6 bar rakes are available for all W/M Sweepers. Individual rubber fingers or rubber flites are also available...whichever suits your ground conditions.



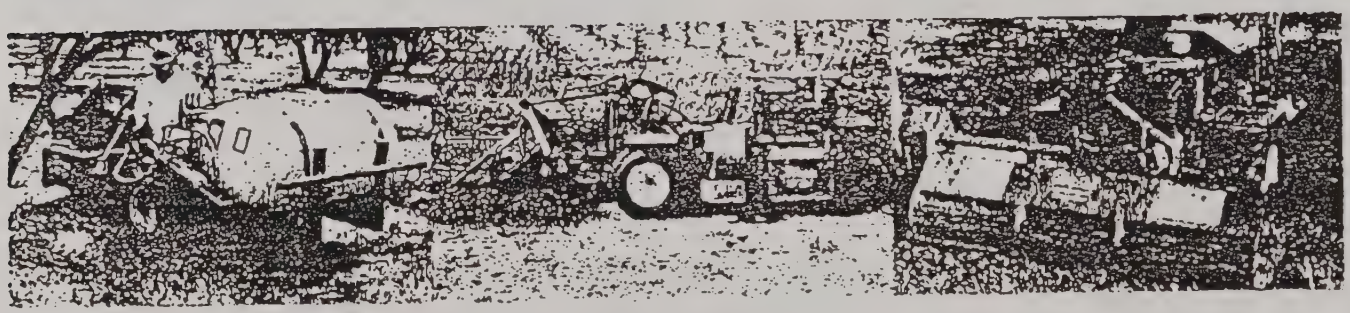
The rugged 40 H.P. DEUTZ diesel engine has more than ample reserve power even with the blower engaged. The engine is well protected with heavy-duty screen to keep out leaves and nuts and yet is easily accessible for servicing.

Dust is the primary cause of engine failures. A large double element Donaldson Air Cleaner plus a dust bowl pre-cleaner assures maximum engine protection.



Gauge wheels provide free-floating action for the sweeper head to follow the contour of the ground.

Convenient up-front control area allows for ease of operation. Power steering and full hydrostatic drive make for easier steering and maneuverability.



Multi-purpose HSD40 can be used throughout the year. Note sprayer, trencher and flail mower attachments... making it the best value in the industry.

S P E C I F I C A T I O N S

AUGER HEADS:
Available in 7', 8', 9' & 10'
TINE BARS:
5 bars — 7'6" & 8'6"
6 bars — 7'6"
ENGINE: DUETZ DIESEL – 40 H.P.
(Optional: Wisconsin 35 H.P. gasoline engine)

STEERING: Power
TIRE SIZES: Drivers — 26 x 12 x 12
Steering — 18 x 9.50 x 8
DRIVE SYSTEM: Hydrostatic
AXLE CAPACITY: 4,000 lbs

FUEL CAPACITY: 13 gallons
POWER UNIT LENGTH: 7'10"
AUXILIARY HYDRAULIC SUPPLY:
8 G.P.M. @ 2,000 P.S.I.
AIR CLEANER: Donaldson 106 Double Element

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(916) 891-6214

WEISS/McNAIR, INCORPORATED
531 Country Drive • Chico, California, 95928 • (916) 891-6214
FAX (916) 891-5905

1995 SWEEPER PRICE LIST

11/8/94

Self-Propelled Orchard Sweepers

Model HSD-40: The HSD-40 is self-propelled with hydrostatic drive. Three point front hook-up. High volume blower. Power steering. Large double element Donaldson air cleaner with pre-cleaner bowl. Dynamic braking through the hydrostat with separate parking brake. 26x12x12 flotation tires. Full floating sweeper head.It is powered by a 42 hp Deutz 1011 L series diesel engine. The cylinder heads are oil-cooled as well as air-cooled. The engine runs at 2500 rpm and is protected by a Murphy safety system that shuts the engine down when pre-set temperature or low oil pressure is exceeded. Safety guarded throughout.

7' Auger Head	$24,750.00
8' Auger Head	24,850.00
9' Auger Head	24,950.00
10' Auger Head	24,950.00
7'6" 5 Tine Bar	24,900.00
Power Unit Only	21,800.00

Model HSD-239: Power unit has a John Deere 4-239 water-cooled diesel engine rated at 70 hp. The unit includes: Power steering, large double element Donaldson air cleaner with pre-cleaner bowl. Three point hook-up, high volume blower with easy adjustable air control. Murphy safety shut off guages, hour meter, radiator rotary screen. Dynamic braking through the hydrostat with separate mechanical parking brake. Safety guarded throughout.

7' Auger Head	$ 29,200.00
8' Auger Head	29,300.00
9' Auger Head	29,400.00
10' Auger Head	29,500.00
11' Auger Head	29,600.00
7'6" 5 Tine Bar	29,400.00
8'6" 5 Tine Bar	29,500.00
7'6" 6 Tine Bar	29,800.00
8'6" 6 Tine Bar	30,200.00
Power Unit Only	27,950.00

OPTIONS:

Brush Guard	$750.00
Burm Wheel	950.00
Air Cab	6500.00

SWEEPER HEADS

Reel Type Heads come with 6 spirals. Standard is every other spiral wire and every other spiral rubber. All rubber may be ordered at a reduced price of $15.00 per foot. Available in 7' to 11' widths.

Tine Bar Sweepers are available in 5 bars for almonds and walnuts and 6 bars for pecans. Six bars are too high for almonds. Tine bars are available with wire rakes backed by rubber fingers, wire rakes backed by wire rakes and wire rakes backed by rubber flites.

TRACTOR MOUNTED SWEEPERS

Weiss/McNair Tractor Mounted Sweepers are available with auger heads 8' thru 11' widths. Tine bar heads are available in 7'6", 8'6" and 9'6" widths. Five bar heads are for walnuts, almonds and filberts and six bar heads are for pecans. These sweepers will adapt to most popular tractors. There are additional charges for custom alterations.

Auger Sweepers		Tine Bar Sweepers	
TRR 8'	$8950.00	7'6" 5 Bar	$ 8850.00
TRR 9'	9000.00	8'6" 5 Bar	9450.00
TRR 10'	9100.00	9'6" 5 Bar	9650.00
TRR 11'	9200.00	13'Vee(2-6'6"heads)	17500.00
12' Vee (2-5 1/2' heads)	15500.00	15'Vee(2-7'6"heads)	18000.00
15' Vee (2-7' heads)	16500.00	17'Vee(2-8'6"heads)	18500.00
17' Vee (2-8' heads)	17500.00		

(For sweeper head only, deduct $1500.00)

If valve stand and controls are deleted, deduct $350.00. Controls and valve may be deleted if tractor had dual remotes and purchaser wants to use tractor remote control. The prices quoted are for tractors that have hydraulic flow of 8 gpm or more.

OPTIONS: Burm Wheel $950.00
Hyd. Pack P.O.A.
(Customer furnishes oil)

Model B-85X 3-point High Volume Blower: $3825.00
This blower fits a standard 3-point tractor hitch.

OPTIONS:		
	Extended Chute for Vee Sweeper	$450.00
	Hydraulic Pack	850.00
	Hydraulically Controlled Air Gate	275.00

Model B-87X 3-point High Volume Blower: $4750.00
80 hp is required.

Model B-87X 3-point Double Outlet: $6850.00
With hydraulically operated air outlet controls.

Optional Air Gate Control Valve	$ 750.00	
Extended Chute for Vee Sweeper	P.O.A.	
Hydraulic Lift for Chute	450.00	
Burm Chute Adaptor only (does not include extension)	400.00	each

DATE: 5/24/95

WEISS/McNAIR, INCORPORATED 531 Country Drive • Chico, California, 95928 • (916) 891-6214
FAX (916) 891-5905

QUOTATION

CUSTOMER NAME U.S. Forest Service

ADDRESS

TELEPHONE

AUTHORIZED PURCHASER Keith Windell

ITEM	AMOUNT
Used HS35 Weiss McNair Sweeper with 7'6" Tine Bar Head - Serial # 80044	$11500.00
Used HS35 Weiss McNair Sweeper with 7'6" Tine Bar Head - Serial # 92009	$14500.00

Special Conditions		
	TOTAL SALES PRICE	
F.O.B Chico, Ca.		
	SUB TOTAL	
	TAX	
	TRADE-IN (if any)	
	DEPOSIT	
	BALANCE DUE AFTER DELIVERY	

ACCEPTED BY: _____ QUOTED BY: Larry Demmer

A Complete Line of Quality Nut Harvesting Equipment

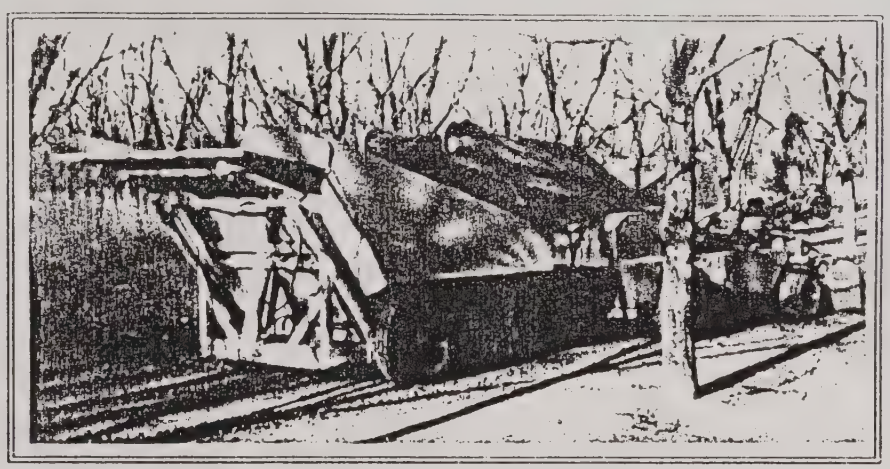
HARVESTERS • RAKES • WINDROWERS

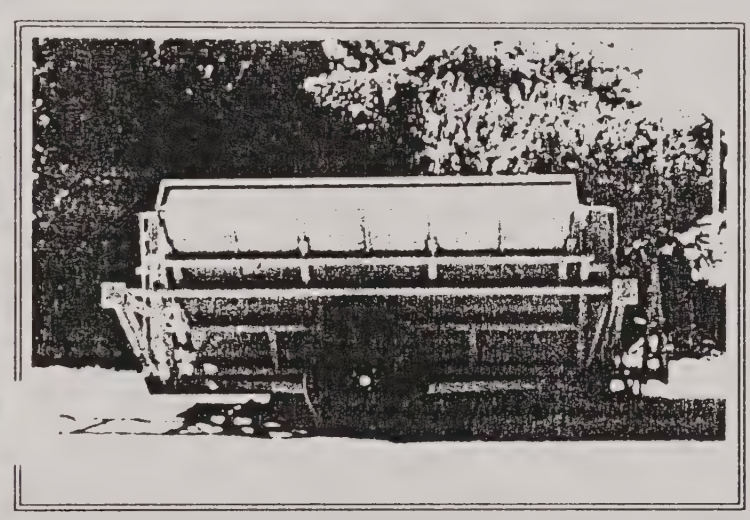
HERBST LO-HI DUMP CARTS

37th Year of Production - Over 1,000 Units Sold

REAR DUMP CARTS

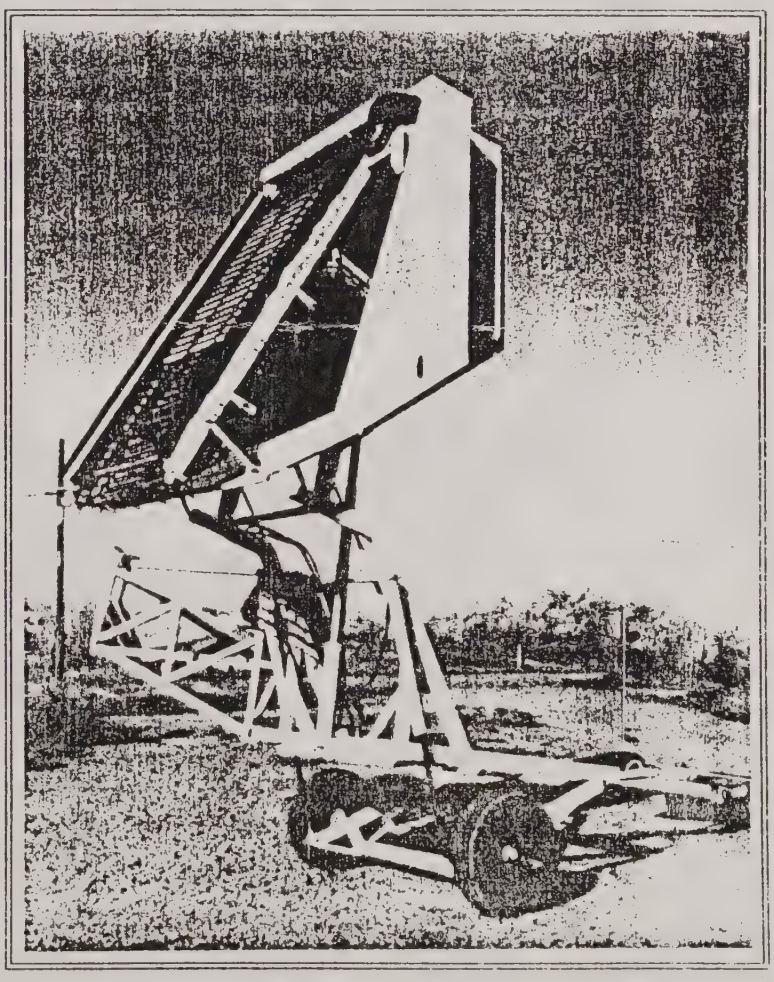
- Standard dump height of 124"
- Capacities of 185, 230 or 300 cu. ft. available. Weight capacities to15,000 lbs.
- High ground clearance and dual-axle models available for muddy conditions





SIDE DUMP CARTS

- Eliminates backing. Ideal for use with pull-type harvesters.
- Operation can be controlled from pickup machine or tractor
- Standard dump height of 120"
- Available in 200, 240 and 300 cu. ft models.



ADDITIONAL FEATURES

- All trailers have weight capacities which allow for dirty operating conditions
- All trailers can be equipped with **HERBST SUPER-CLEAN DESTICKERS** and stick catching bins
- **Trailers are painted to match existing equipment when requested at no additional charge.**
- Custom size and style trailers available to meet your needs

HERBST MFG. INC.

P.O. BOX 67 ESPARTO, CA 95627

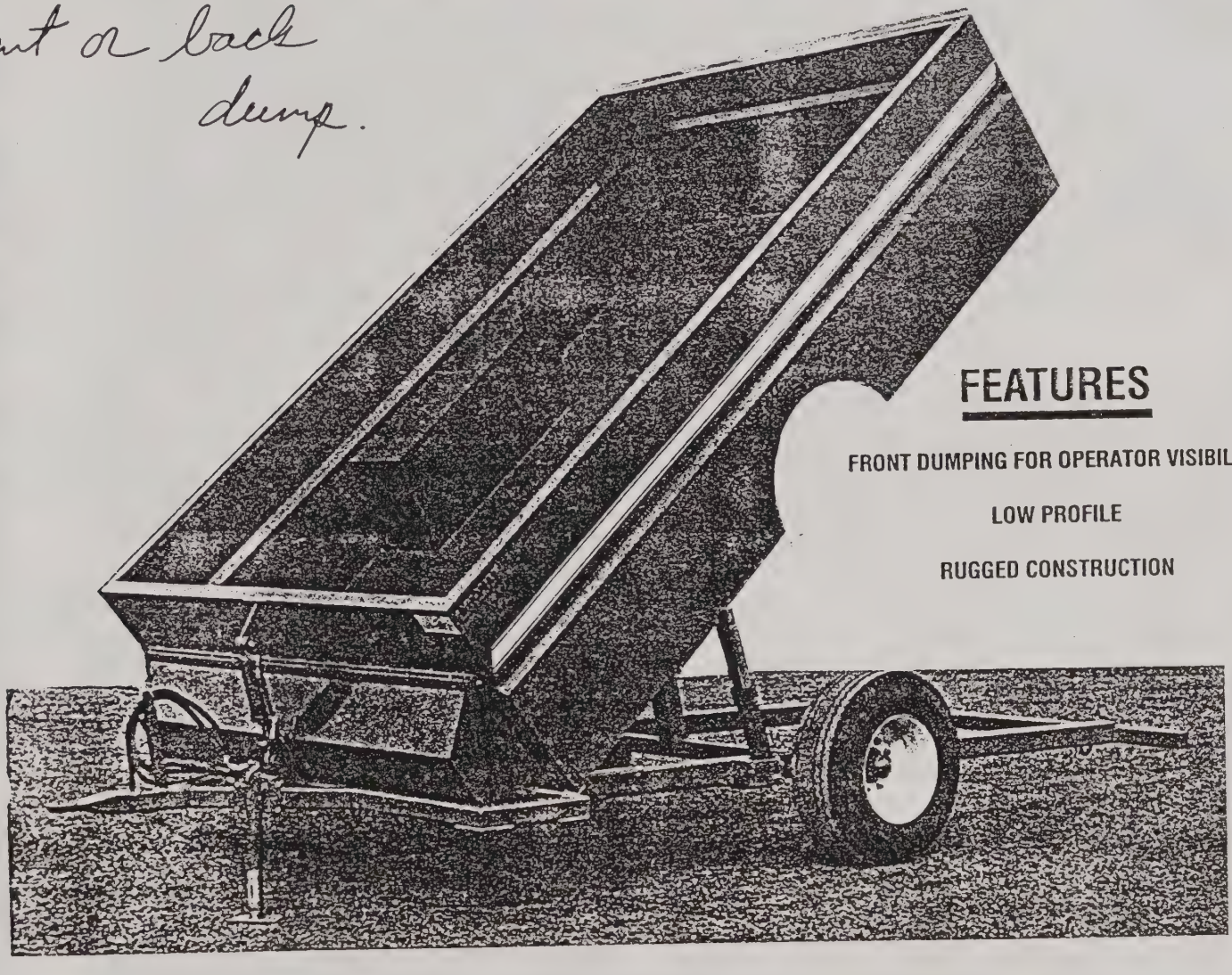
(916) 787-3460

$7000.00

front or back dump.

THE THOMAS NUT CART

Drive-Over Hydraulic Dump



FEATURES

FRONT DUMPING FOR OPERATOR VISIBILITY

LOW PROFILE

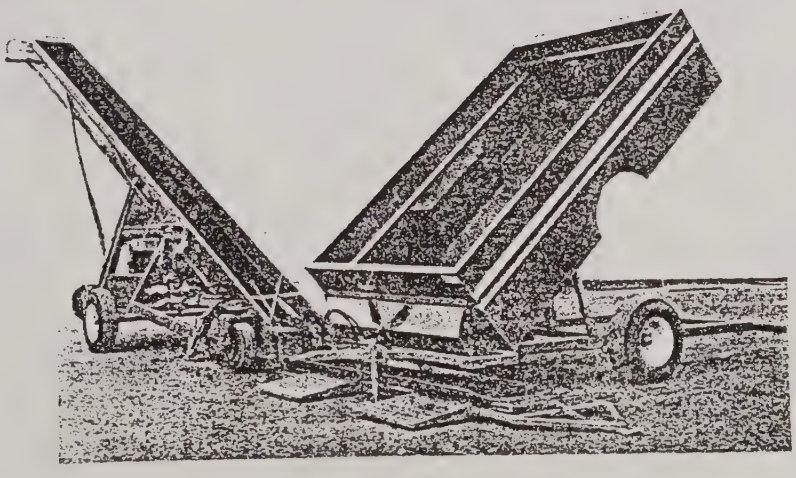
RUGGED CONSTRUCTION

SPECIFICATIONS

Standard Width	8 ft.
Standard Length	12 ft.
Standard Height	5 ft.
Capacity	360 cu. ft.
Augers	10 in.
Tires	12 – 16.5

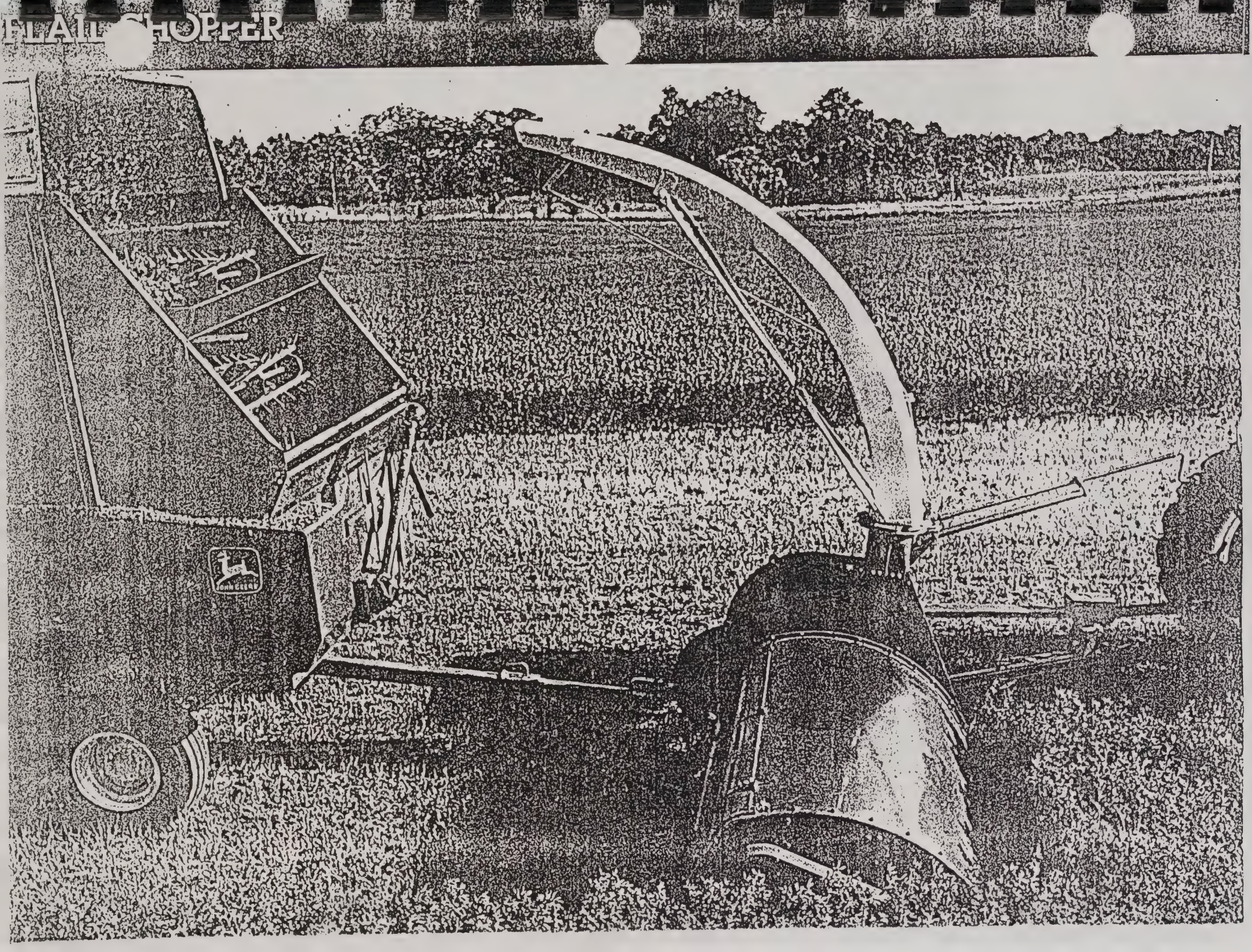
OPTIONS

- Auger motor assembly
- 3-point quick hitch
- Pintle-type hitch on both ends eliminates manual lifting



THOMAS
WELDING & MACHINE SHOP

1308 West Eighth Avenue
Chico, California 95926 U.S.A.
916-893-8940 • Fax 916-893-2943
Thomas Dauterman, Owner/President


FLAIL CHOPPER

Whatever the weather, the low-cost 6-foot-cut 16A Chopper can handle the job

Rain or shine, when your green-chop program demands cut feed every day, the 16A Flail Chopper delivers.

A simple, but rugged design provides dependable performance. Two rows of free-swinging, double-edged knives cut a standing crop and lift it into a transfer auger. The 12-inch auger then swiftly moves the crop to a knife-tipped fan. Three knives [illegible] even flow before it's delivered to the wagon.

Free-swinging knives retract if they hit an obstruction. The knives are mounted on a single rod which rides on a two-bank rotor. Heavy-duty bearings in cast-iron housings offer dependable performance. The bearings are also equipped with anti-wrap shields for longer life.

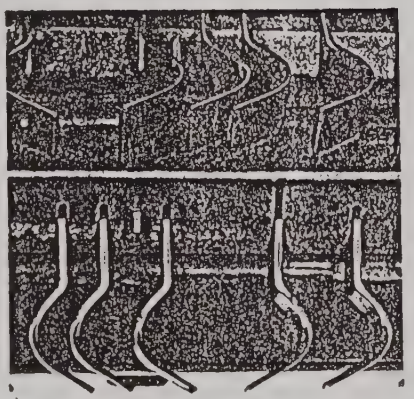
Four tongue positions let you center the chopper on the rows. Or you can offset the chopper so the tractor tires do not run over the crop. A transport position places the 16A behind the tractor.

An equal-angle hitch helps reduce powerline vibration and wear during turns. A handy jackstand and PTO holder simplify tractor hookup.

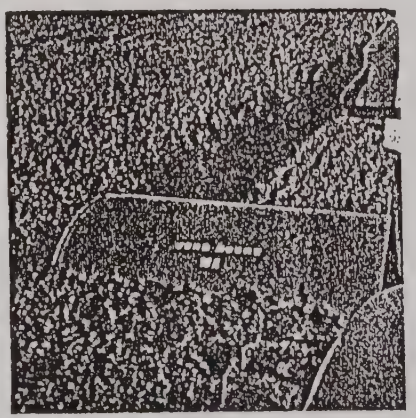
Simple hand crank controls let you set the cutting height. An optional hydraulic cylinder lets you adjust cutting height from the tractor seat. The spout position is also controlled from the tractor seat.

All drives are heavy-duty for added reliability. The main drive is protected by an overrunning clutch. A shear pin protects the auger.

This chopper is also a great way to shred crop residue. You can use the 16A Flail Chopper to shred cornstalks for bedding or a low-cost feed. If you just want to shred crop residue, the auger door can be opened for uniform spreading. Or you can remove the auger and auger housing and shred heavy brush with it. It's truly a low-cost machine you can use for a variety of cutting chores around the farm.



Forty-two curved knives lift the material as it's cut. They're free-swinging so they retract if they hit an obstruction.



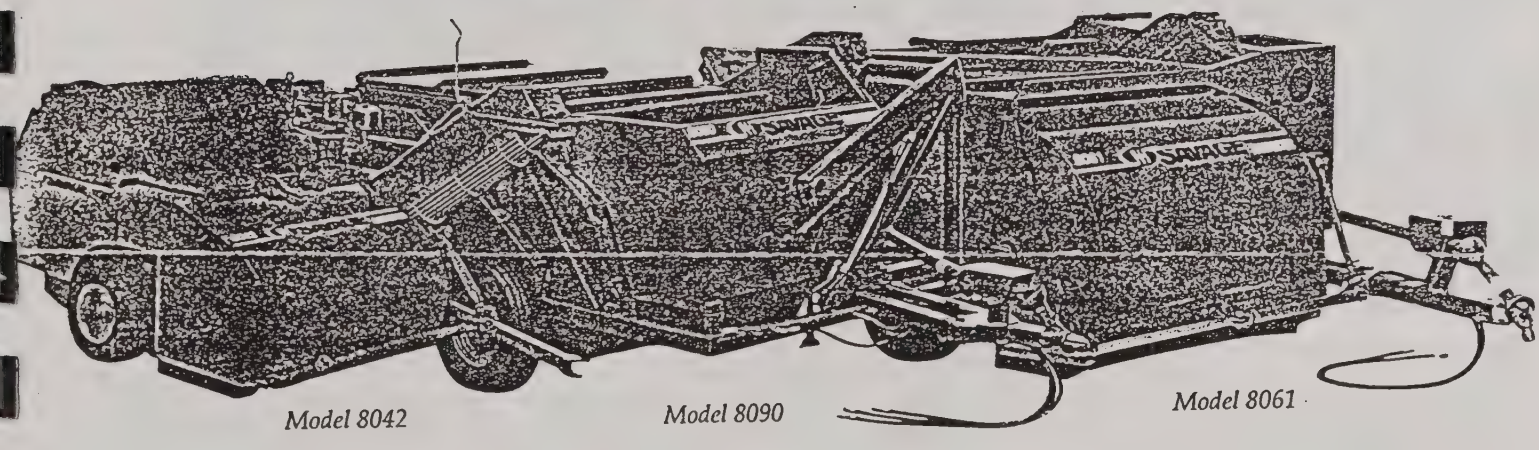
The rotary chopper can be offset so the tractor tires do not run over the crop. A 6-foot cutting width makes quick work of big fields.

Specifications

(Specifications and design subject to change without notice.)

Operating width 10 ft. 3 in. (3.12 m)
Transport width . . 9 ft. 5 in. (2.87 m)
Length (with discharge spout to rear) . . . . . 12 ft. (3.66 m)
Height
With spout . . . . 10 ft. 3 in. (3.12 m)
Less spout . . . . . 5 ft. (1.52 m)
Weight (approx.) . . 1870 lb. (849 kg.)
Tires . . . . . 15-5.90, 4-PR (28 psi)
Number of rotor knives . . . . . 42 (double-edge)
Number of cutterhead knives . . . . . 3 regular
3 extra equipment
Cutting width . . . . . 6 ft. (1.83 m)
Cutting height . . . Adjustable, 2½ to 6 in. (64 to 152 mm)
Size of tractor . . . . . 45 to 60 hp (34 to 45 kW) without slip clutch; 45 to 75 hp (34 to 56 kW) with slip clutch
PTO . . . . . 540 rpm
Rotor speed . . . . . 1400 rpm
Auger speed . . . . . 246 rpm
Attachments: 18-inch (457 mm) spout extension; "contour" knives for cutting on raised rows; three extra cutterhead knives; axle extensions.

GET TO YOUR PECANS... AND GET THEM UP... BETTER!



Model 8042 *Model 8090* *Model 8061*

NH-SAVAGE Harvesters mean maneuverability, maximum pickup and maximum trash separation.

When it comes to harvesting Pecans, maneuverability is critical. So is maximum nut pickup from the orchard floor and the elimination of unwanted trash. Finally, you need the ability to really "get after it" and cover some ground when the conditions are best. All NH-SAVAGE Harvesters, including the 8042 lawn tractor Harvester designed for the small operation, are up to the challenge!

More Maneuverability

NH-SAVAGE Harvesters are designed to move around the trees and other objects easily - even around the kind of unevenly spaced trees found in native orchards.

Maximum Pickup

NH-SAVAGE Harvesters provide more thorough pickup - even in rough terrain. Their special rotating pickup "fingers" get into the depressions and cut through tough grass and leaves to get to the pecans.

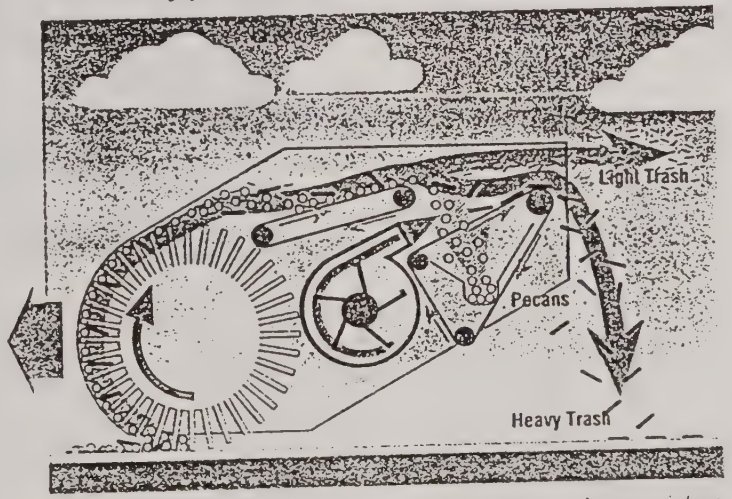
NH-SAVAGE harvesters are designed for maximum elimination of sticks, leaves and husks using an efficient, "straight through" trash separation system. Right out of the Harvester, nuts are cleaner.

Easy transfer

With NH-SAVAGE Harvesters, pecan transfer time is minimal. Both the 8061, and the 8090 feature a large storage bin. When it's time to unload, a unique hydraulic dumper lifts and dumps the bin up over the trailer. And with the 8042 Harvester, nuts fall directly into pecan sacks for easy movement and storage.

Reliability

A minimum of moving parts and exceptional design means reliability. One only has to look at the resale value on NH-SAVAGE harvesters to get a hint as to the years of service they provide.



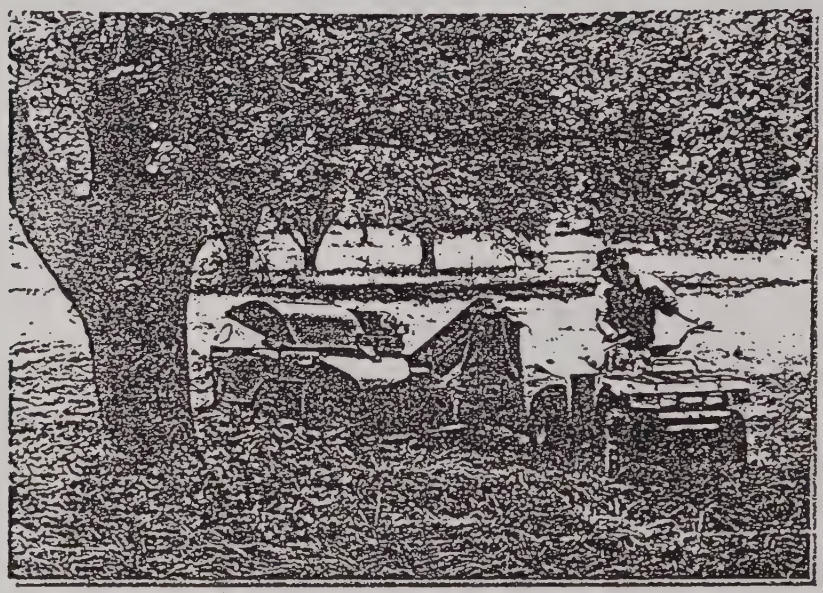
NH-SAVAGE Harvesters are designed for maximum pickup and maximum trash separation.

See your NH-SAVAGE dealer today to get a Harvester that's really up to the task.

SAVAGE

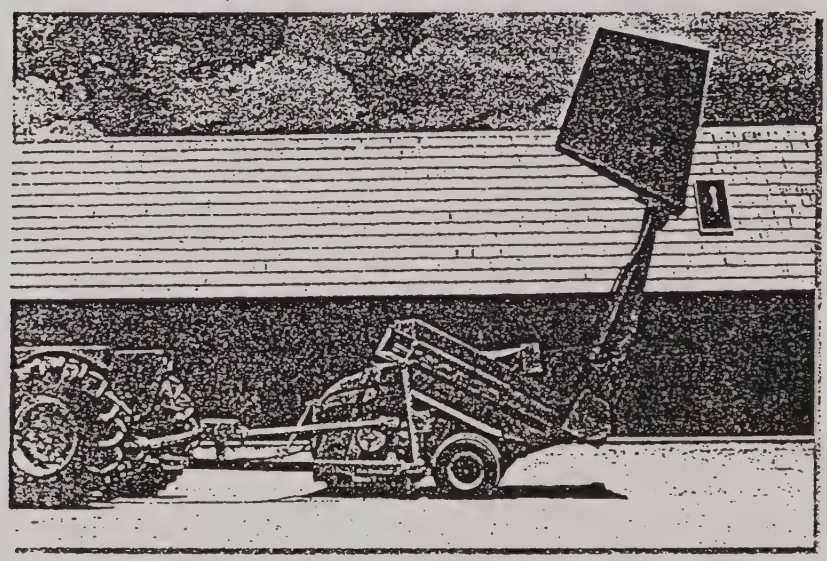
400 Industrial Road
Madill, OK 73446
(405) 795-3394

HC 03, Box 18
Lampasas, TX 76550
(512) 556-8247



The 8042 Harvester is perfect for the small grower

The 8042 augers nuts into sacks for easy movement and storage



The hydraulic hopper on the 8061 and 8090 makes dumping into a trailer easy

The lid of the 8061 lifts with the hopper for easy access

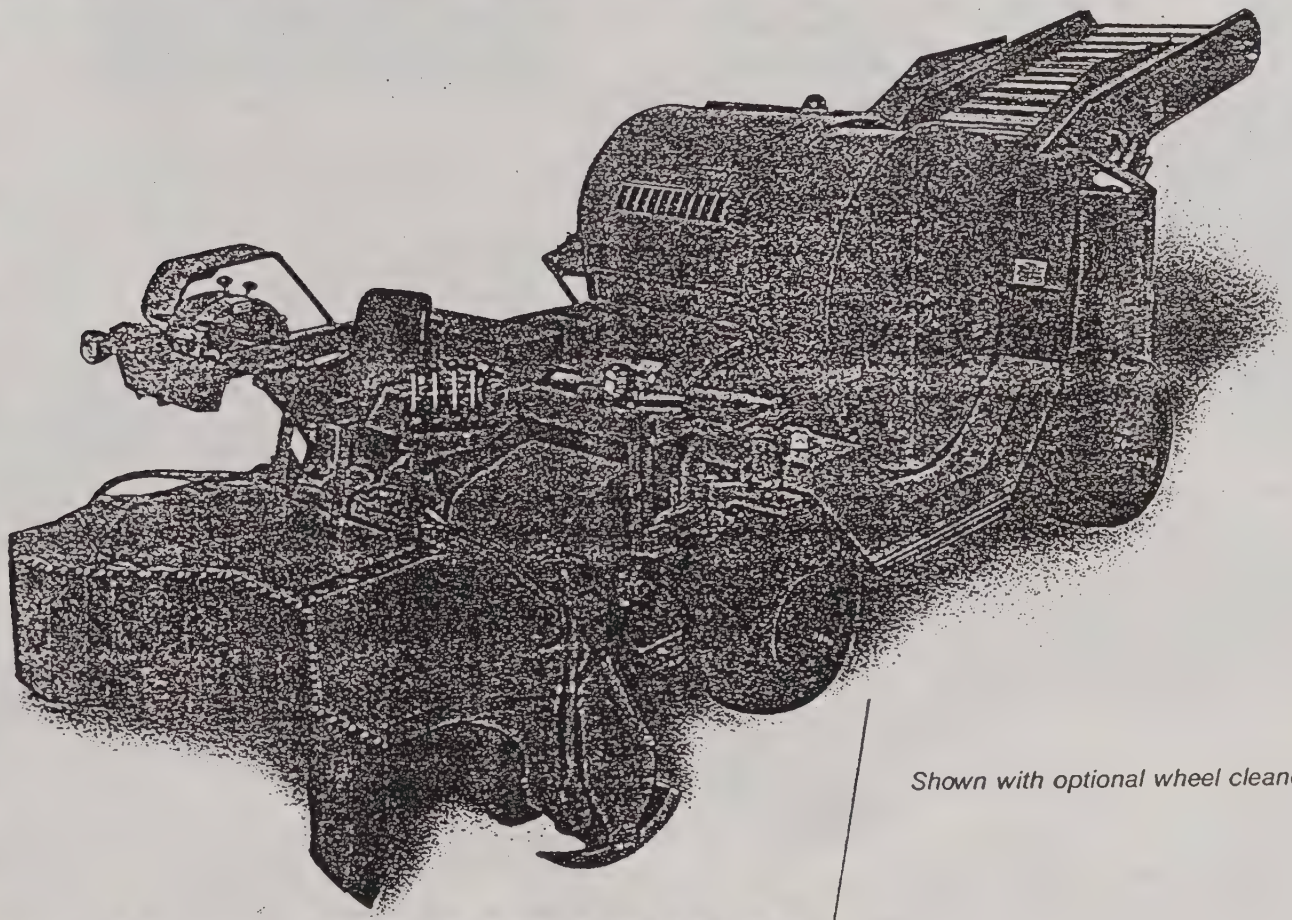
Unique plates makes changing fingers simple on NH-Savage Harvesters

MODEL	POWER SOURCE	NUT STORAGE	PICKUP WIDTH	FINGER SIZE	NUTS PER DAY	TOW TO PICKUP METHOD	WEIGHT	LENGTH	HEIGHT	WIDTH
8042	16HP	Sacks	42"	7.5"	to 2200	Manual	1190	102"	48"	66"
8061	35HP/540PTO	800lb Bin	61"	10"*	to 12000	Hydraulic	3370	166"	67"	101"
8090	35HP/540PTO	1000lb Bin	61"	7.5"	to 12000	Hydraulic	3640	180"	70"	94"

* 7.5" fingers optional on the 8061

Specifications subject to change without notice

RAMACHER



Shown with optional wheel cleaner.

ne New RAMACHER

9600

SERIES

Self-propelled Harvesters

Pecan 9600
Walnut 9610
Almond 9620
Filbert 9630
Fig 9640
Macadamia 9650

PATENTED AERO-PIC SYSTEM. Allows faster speeds for more tonnage per hour while removing grass, leaves and other trash for a cleaner load.

LONG LIFE CONVEYOR SYSTEM. Chain frame reduces wear and stoppages. System is supported completely by rollers and sprockets for long life.

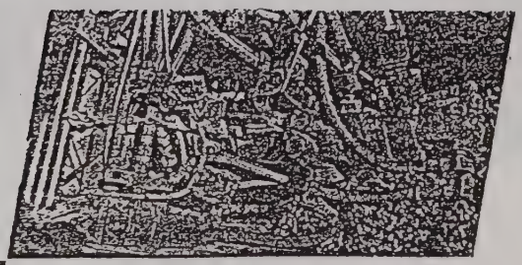
EFFICIENT POWER UTILIZATION. One large efficient suction fan. New hydraulic system for efficiency and maximum energy transfer.

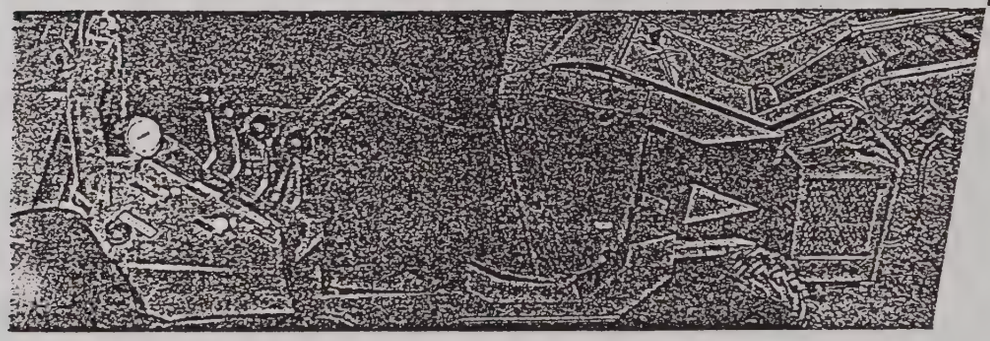
MECHANICAL SIMPLICITY. Designed with fewer moving parts for reliability and low maintenance cost.

If you are looking for a high performance harvester that offers speed, low maintenance, operation ease and a great return on investment, buy a new Ramacher 9600 Self-propelled Harvester.

Ask your Ramacher salesman for a demonstration today.

Exclusive features from RAMACHER





Power System

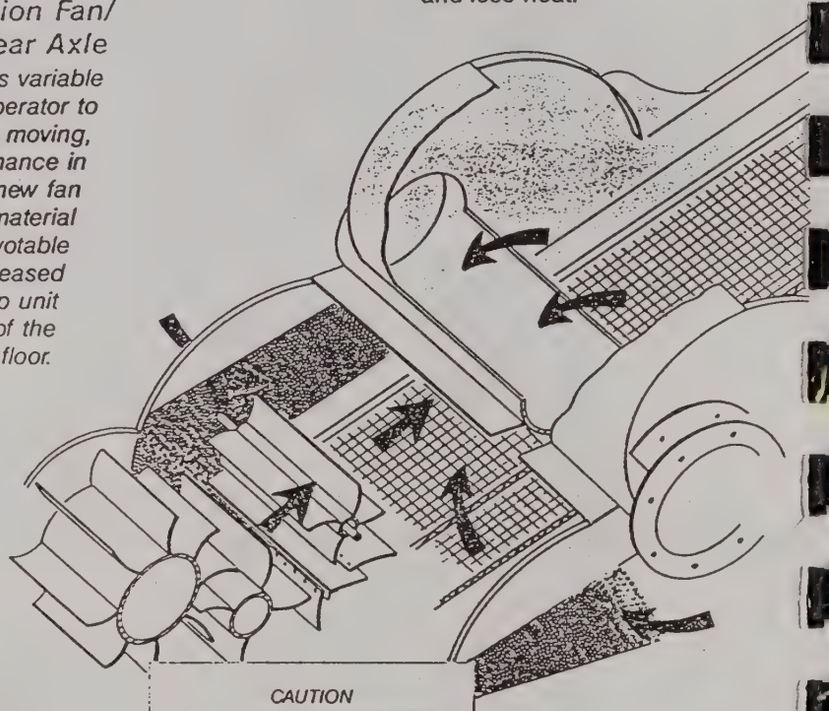
The Ramacher 9600 is powered by a turbocharged John Deere Diesel engine coupled to a hydraulic system utilizing high quality components. This design significantly reduces maintenance and breakdowns. The engine and cooling system have been placed for optimum operator environment — low noise, better visibility and less heat.

Control System

The 9600 controls are easy to use. Push forward starts all functions, pull back stops. The fan and conveyor are variable speed, with the conveyor having an additional 2 speed control to help eliminate crop spillage while turning back into windrow.

Suction Fan/ Pivotable Rear Axle

Powerful Suction Fan has variable speed control allowing operator to adjust air pressure, while moving, for maximum performance in varying conditions. The new fan liner made from high tech material provides long life. The pivotable rear axle provides increased traction and allows pick-up unit to follow the contour of the orchard floor.



Patented Aero-Pic System

Years of research and testing went into the design of this system. The red arrows show how a low velocity air flow takes the leaves, dirt and trash from the dual pick-up reels. The green arrows show the higher velocity air flow that holds the leaves and trash in suspension until removed by the powerful suction fan.

Options:

Wheel Cleaners
4 Wheel Drive (For extremely adverse conditions.)
Light Kit
Murphy Switches
Trailer and Bankout Controls

Specifications:

Weight: 7600 lbs.
Height: 73", 79" or 85"
(Field Adjustable Conveyor Height)
Width: 8'3"
Length: 20'

Specifications Subject to Change

CAUTION
Before using the equipment described hereon, be sure to read the WARNINGS outlined in the Operating Manual and attached to the machine itself.

WARRANTY

RAMACHER MANUFACTURING COMPANY (RAMACHER) warrants each new harvester or sweeper and parts manufactured by it to be free from defects in material and workmanship under normal use and service. The obligation of RAMACHER shall be limited to replacing any part which shall, within 180 days after delivery to the original purchaser, be returned to RAMACHER with transportation charges prepaid and which an examination by RAMACHER discloses is defective. This Warranty does not obligate RAMACHER to bear the cost of labor in connection with the replacement or repair of defective parts.

This Warranty is expressly in lieu of all other warranties and representations, expressed, implied, or statutory, including warranties of merchantability and fitness for a particular use, and all other liabilities or obligations on the part of RAMACHER, foreseeable or not.

No warranties or representations made by persons other than representatives of RAMACHER expressly authorized in writing to do so shall be valid and binding upon RAMACHER. No dealer shall be authorized to bind RAMACHER in this respect.

RAMACHER makes no warranty with respect to component parts not manufactured by RAMACHER, including, but not limited to, engines and power trains. This Warranty shall not apply to any equipment which has been altered in any way outside of manufacturer's factory, or which has been subject to misuse, neglect or accident.

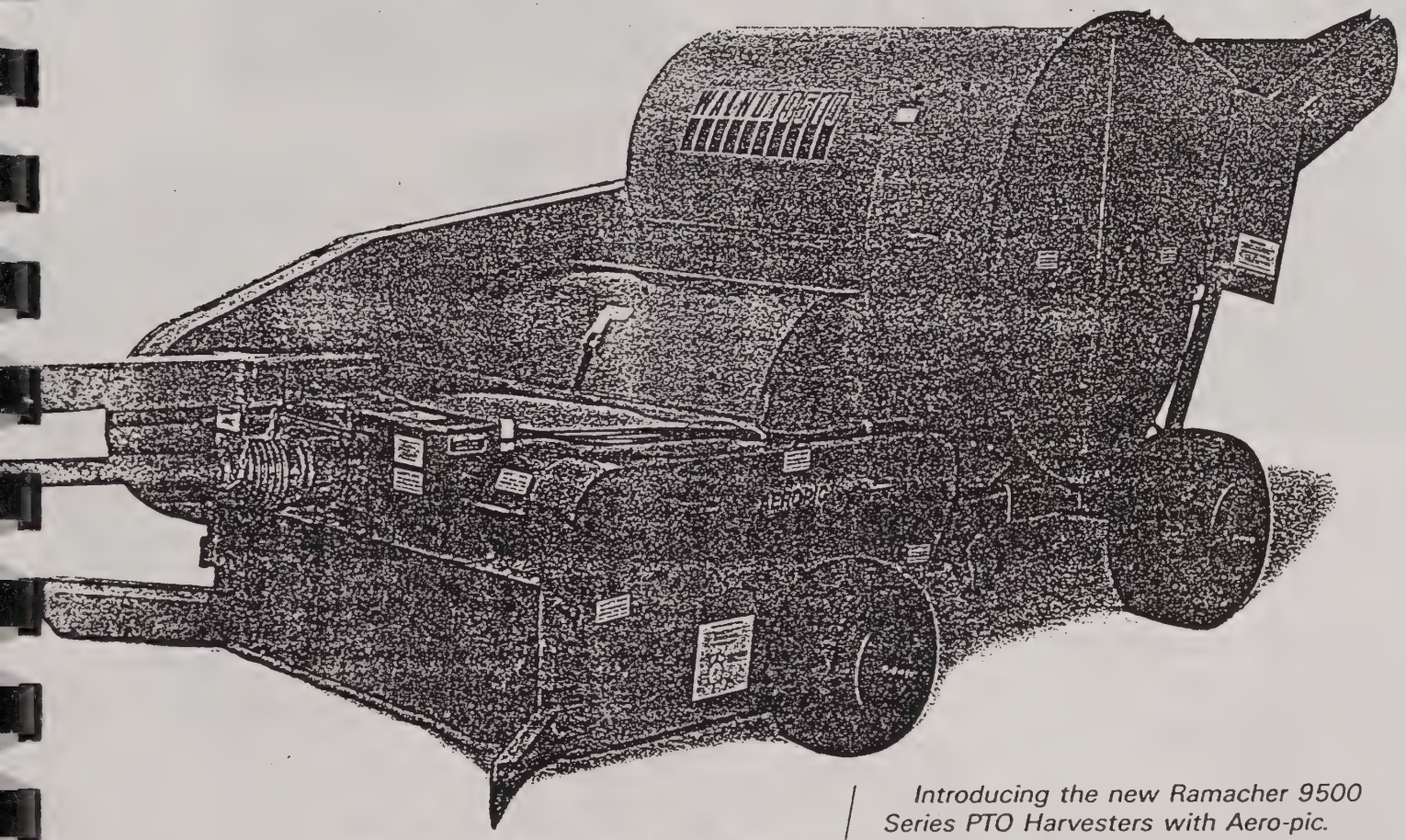
MANUFACTURING RAMACHER COMPANY

Come harvest time . . . you'll be glad you own a Ramacher!

P.O. Box 506 • Linden, California 95236 • 209/887-3815

6/90 2.5M

RAMACHER



The new RAMACHER 9500 SERIES PTO HARVESTERS

Pecan 9500
Walnut 9510
Almond 9520
Filbert 9530
Fig 9540

Introducing the new Ramacher 9500 Series PTO Harvesters with Aero-pic. A system so advanced its efficiency and dependability are unsurpassed.

The Aero-pic System incorporates Ramacher's proven components; a dual-reel soft pick-up, a powerful suction fan, and an aerodynamically-designed separation chamber.

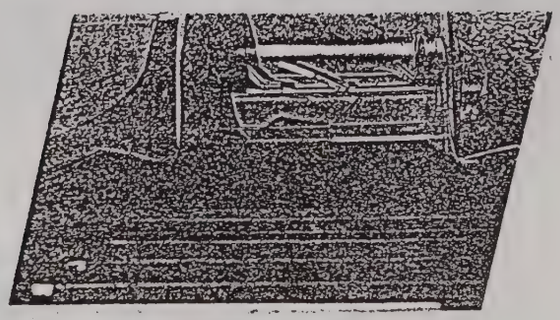
The dual pick-up reels have been re-designed to pick up large, wet and dirty windrows at high speed without damage to crops. The windrow is continuously showered into the separation chamber where its aerodynamic design actually sculptures the air flow to suspend the mixture and remove just the trash and leaves. The nuts then gently fall onto the conveyer belt system where they are quickly whisked to the trailer.

To eliminate plugging, the 9500 Series PTO Harvesters feature a one foot vertical clearance in the separation chamber. Logs could even pass through without damage to the harvester or its components.

Take a look at the new 9500 Series PTO Harvesters with the Aero-pic System, you'll find them to be the most advanced harvesters in the industry.

Ask your Ramacher salesman for a demonstration today.

Exclusive features from RAMACHER



No-slip conveyer system

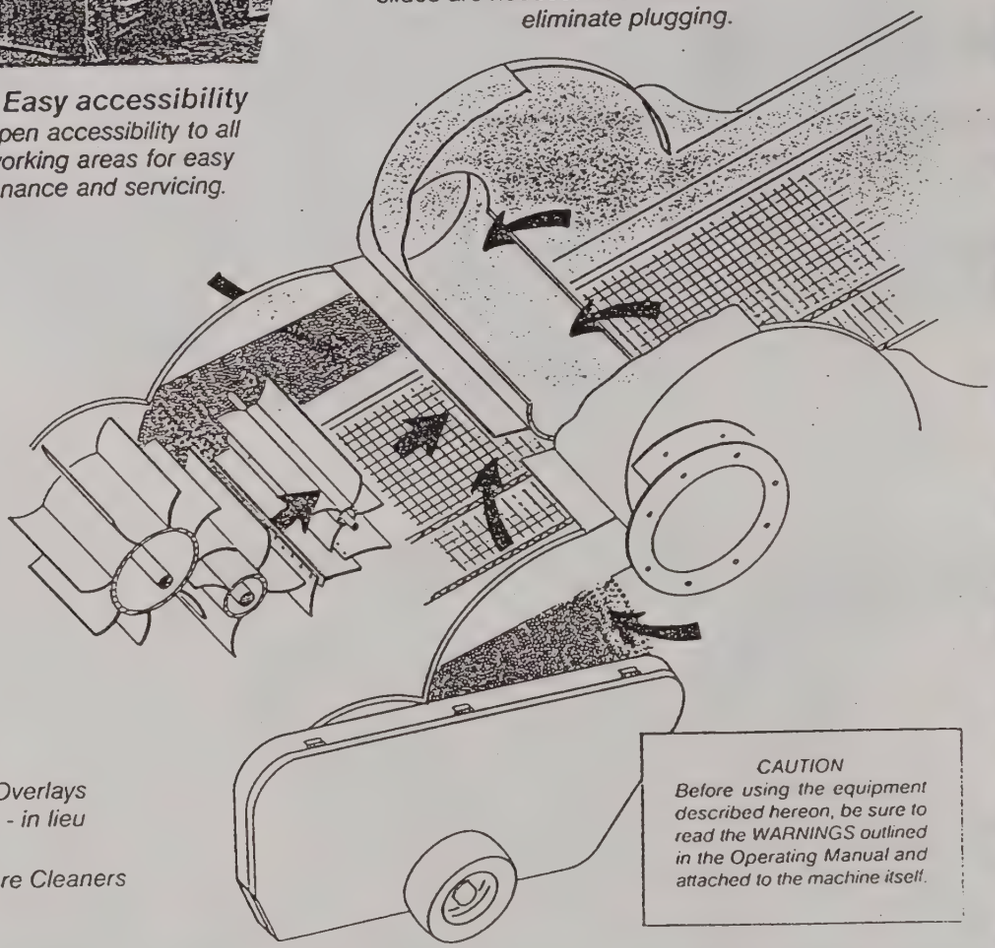
Conveyer belt is built Ramacher tough with the balanced spiral mesh sandwiched between a "Roller Chain Drive Frame" and flites (Rod and Tube Chains available). The system is supported completely by rollers and sprockets for long life. No slides are needed. Stickbreakers eliminate plugging.

Unique backfeeder system

Backfeeder system pivots to go over rocks and roots for a clean pickup.

Easy accessibility

Open accessibility to all working areas for easy maintenance and servicing.



Aerodynamically designed separation chamber

Years of research and testing went into the design of this chamber. The red arrows show how a low velocity air flow takes the leaves, dirt and trash from the dual pick-up reels. The green arrows show the higher velocity air flow that holds the leaves and trash in suspension until removed by the powerful suction fan.

Specifications:

- *Weight 4200 lbs.*
- *Height 6' 11"*
- *Width 6' 9"*
- *Low and easy maintenance*
- *Low HP requirements*
- *Slip clutches protect drive components*

Options:

- *Fan Blade Overlays*
- *Flex Combs - in lieu of rubber*
- *Hydraulic Flare Cleaners*

CAUTION

Before using the equipment described hereon, be sure to read the WARNINGS outlined in the Operating Manual and attached to the machine itself.

WARRANTY

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Come harvest time . . . you'll be glad you own a Ramacher!

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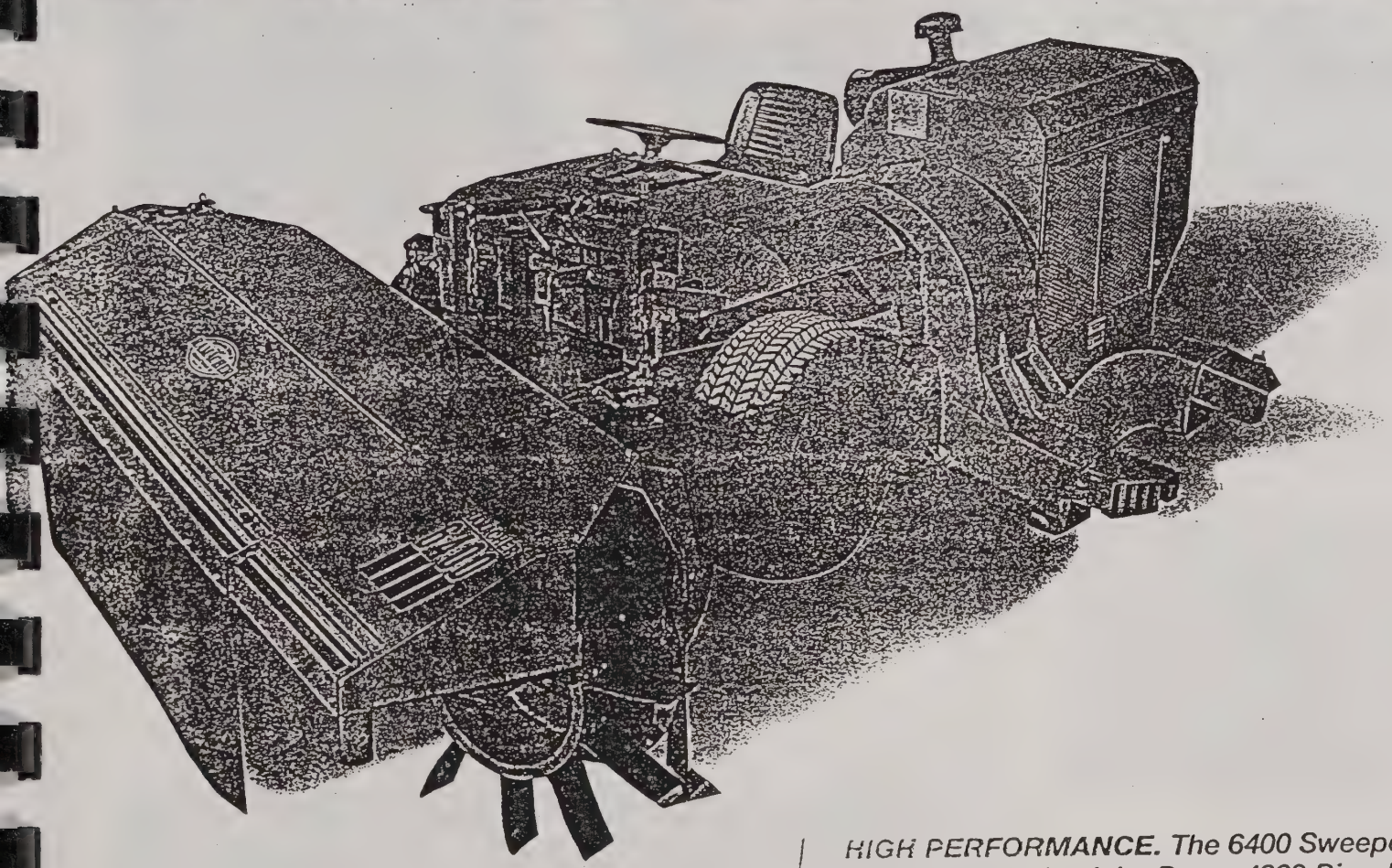
MANUFACTURING RAMACHER COMPANY

1-90-5M

RAMACHER



The New RAMACHER 6400 SWEEPER

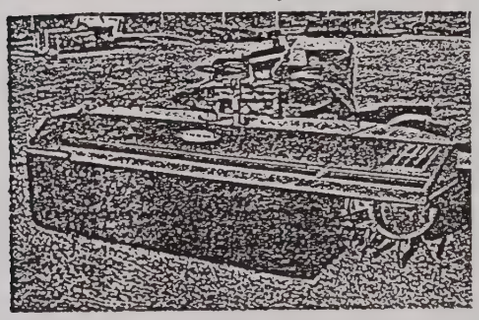
HIGH PERFORMANCE. The 6400 Sweeper is powered by the John Deere 4239 Diesel Engine. This engine is built to last and can produce 70 HP when operated at 2200 RPM. The 6400 has increased blower power to provide the largest blowing capacity in the industry.

LOW MAINTENANCE. The Ramacher 6400 Sweeper has an advanced hydraulic system and hydrostatic drive to reduce down time. The pump drive is newly designed to eliminate belt maintenance and periodic slippage common to belt drives.

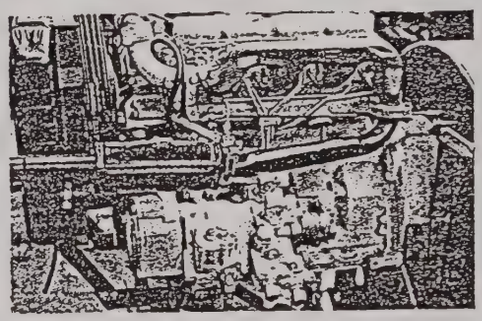
ENGINEERED FOR SAFETY AND DURABILITY. This new model offers maximum operator convenience and safety. The 6400 blower has a new foot control design that leaves the operator's hands free for other controls. The specially designed blower output system allows the operator to control the blower output with the engine's RPM, resulting in longer engine life, less fuel consumption and more quiet operation.

[illegible]. Check out the Ramacher 6400 Sweeper. It offers quality and performance at an affordable price. Ask your Ramacher Salesman for a demonstration today!

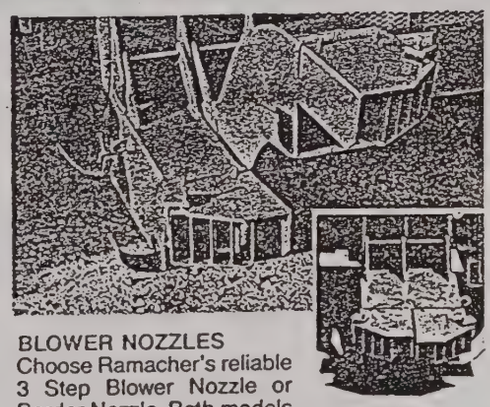
Features exclusively from RAMACHER



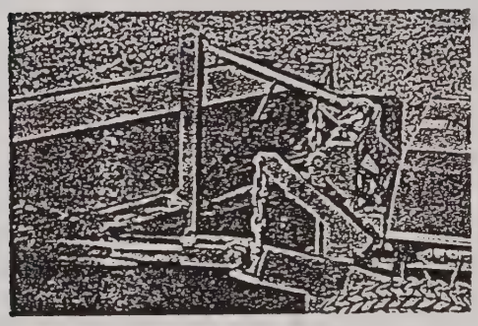
ROTARY HEAD - 5 BAR RAKE HEAD
Rotary heads are available in 7', 8', and 9' wide sizes. Rake bar heads are available in 6', 7', and 8-½' widths. To ensure less dirt in the windrow, the flights of the head or rake bars can be assembled with wire rakes and optional Ramacher "Flex Combs." The sleek, low profile design means the head can get closer to the base of the tree.



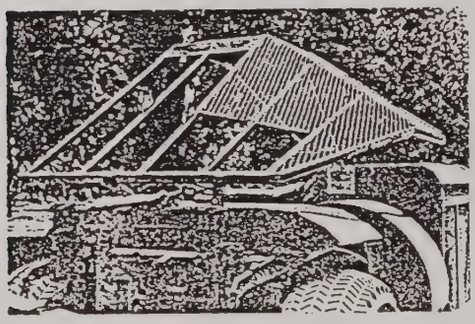
JOHN DEERE POWER WITH DIRECT DRIVE HYDRAULICS
The powerful John Deere 239 cu. in. 70 HP Diesel Engine is equipped with an advanced pump drive that replaces drive belts. This new design significantly lowers maintenance costs while providing Deere dependability.



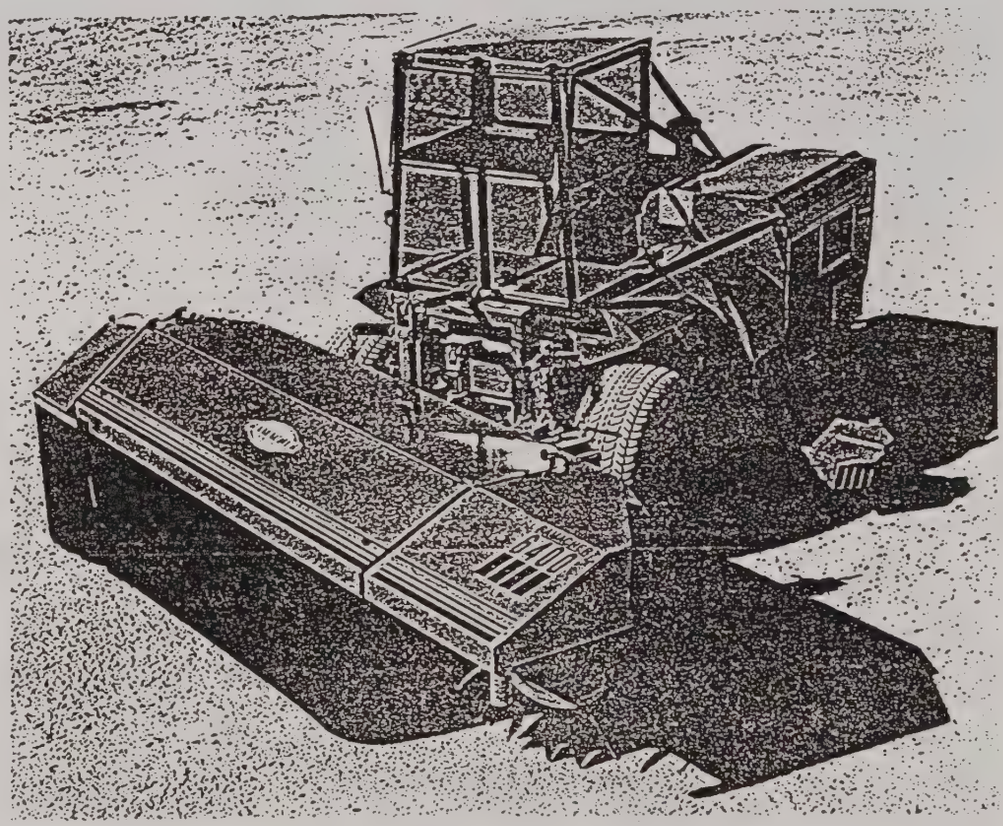
BLOWER NOZZLES
Choose Ramacher's reliable 3 Step Blower Nozzle or Border Nozzle. Both models are constructed to allow the operator more control with directional louvers.



3 POINT VERSATILITY
The 6400 Series Sweeper offers the versatility of a front mounted 3 point hitch. This hitch permits easy removal of the head, as well as the use of other 3 point attachments and tools.



LIMB GUARD (OPTION)
The Limb Guard protects the operator from tree limbs while maintaining excellent visibility.



AIR CAB (OPTION)
Ramacher leads the industry with the first Air Cab. This cab provides air conditioned comfort and shelters the operator from dust and debris.

SPECIFICATIONS

- 239 cubic inch water cooled John Deere Diesel Engine
- 21 gallon diesel fuel tank
- Tri-phase air cleaner
- "Fail-safe" brake system
- High-flotation tires
- Length (7' std. head): 14'6"
- Width (7' std. head): 9'2"
- Height (engine cover): 44"

OPTIONS

- Limb guard
- Air Cab
- 6', 7', 8-½' five bar rake heads
- 7', 8', 9' rotary heads
- All wheel drive
- Flex combs or rubber fingers
- Running lights
- Murphy switch

RAMACHER
MANUFACTURING INC.

COME HARVEST TIME...YOU'LL BE GLAD YOU OWN A RAMACHER.

P.O. Box 506 Linden, CA 95236
Telephone 209/887-3815 Fax 209/887-3248

1/92 5M

RAMACHER
5023 N. Flood Road
Post Office Box 506
Linden, California 95236
Fax: 209-887-3248
209-887-3815

1/10/95

PRICE LIST - SWEEPERS

AIR COOLED DIESEL - DEUTZ 40 HP	DOLLARS
4470 7' 5-Bar Rake Head	21,100
4485 8 1/2' 5-Bar Rake Head	21,900
WATER COOLED DIESEL - JOHN DEERE 70 HP	
6460 6' 5-Bar Rake Head	27,300
6470 7' 5-Bar Rake Head	27,900
6485 8 1/2' 5-Bar Rake Head	28,700
6470 7' Rotary Head	26,700
Add $360.00 for each additional foot up to 10'	
6570 Standard 7' 5-Bar Rake Head	29,450
6585 Standard 8 1/2' 5-Bar Rake Head	30,400
6560 HCH 6' 8-Bar Rake Head	29,950
6570 HCH 7' 8-Bar Rake Head	31,000
TRACTOR MOUNT (TM Heads Priced Without PTO Blower)	
TMR-70 ROTARY TYPE HEAD (Includes RMC Blower)	9,600
Add $360.00 for each additional foot up to 10'	
TM-85 8 1/2' 5-Bar Rake Head	10,900
TM-HCH 80 8-Bar Rake Head	13,000
DW-PTO Blower Cat. 2, 3-Point	4,600
RMC-PTO Blower Cat. 2, 3-Point	3,450
OPTIONS	
Murphy Switch	320
Limb Guard (All Self-Propelled Sweepers)	1,290
Night Lights (All)	410
Air Cab With Radio-Hi Flotation Tire (6500)	7,300
Air Cab With Radio (6400)	5,250
Rear Wheel Drive (6500-6400)	2,300
Blower Nozzle (6500-6400) 3 Step	330
Blower Nozzle (6500-6400) Border	660
Front Wheel Drive (4400)	1,300
Adj. Reel Speed (4400)	250

ALL PRICES F.O.B. LINDEN, CALIF. PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

506
...en, California 95236
Fax: 209•887•3248
209•887•3815

1/10/95

PRICE LIST - HARVESTERS

	DOLLARS
PTO HARVESTERS	
DCS - PTO	27,500
9500 Pecans	22,600
9510 Walnuts	22,450
9520 Almonds	21,800
9530 Filbert	21,800
9540 Figs	21,800
9500 H Pecans	23,600
9510 H Walnuts	23,450
9520 H Almonds	22,800
9530 H Filberts	22,800
9540 H Figs	22,800
9500 HSC Pecans	26,300
9510 HSC Walnuts	26,150
9520 HSC Almonds	25,500
9530 HSC Filberts	25,500
9540 HSC Figs	25,500
SELF PROPELLED HARVESTERS - JOHN DEERE 110 HP	
DCS - SP	62,500
9600 Pecans	59,400
9610 Walnuts	58,900
9620 Almonds	57,700
9630 Filberts	57,700
9640 Figs	57,700

ALL PRICES F.O.B. LINDEN, CALIF. PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Box 506
Linden, California 95236
Fax: 209-887-3248
209-887-3815

1/10/95

PRICE LIST - HARVESTER OPTIONS

OPTIONS	DOLLARS
Dual Wheel Cleaners (9600)	5,230
Flare Cleaners (9500) Closed Center Hyd.	2,530
Flare Cleaners (9500) Open Center Hyd.	2,760
Extra Chain (9500) - Walnut Tube 78500-01	2,488
Almond 78369-02	1,306
Pecan/Filbert 78369-03	1,521
Pecan/Filbert Rod 78514-01	2,431
Extra Chain (9600) - Walnut Tube 78502-01	2,778
Almond 78499-03	2,430
Pecan/Filbert 78499-06	1,480
Pecan/Filbert Rod 78513-01	2,836
Hydraulic Hitch (9500)	350
Esparto Hyd. Trailer Controls	1,200
Auger Cart Motor & Control W/Hoses (9600)	920
Auger Cart Motor W/Hoses (9500)	650
Night Lights (All)	580
Bankout Controls (9500)	2,700
Bankout Controls (9600) (DCS SP)	1,340
4-Wheel Drive (9600)	7,950
Murphy Switch (9600) Oil & Water	440
Tote Box Funnel (9500-9600)	*
Air Cab (9600)	*

* Price Available Upon Request

ALL PRICES F.O.B. LINDEN, CALIF. PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

NEW

The NEW FLORY 480 P.T.O. and 4800 SELF-PROPELLED HARVESTERS with the NEW Tri-Sep Cleaning Systems

FI
FLORY
INDUSTRIES

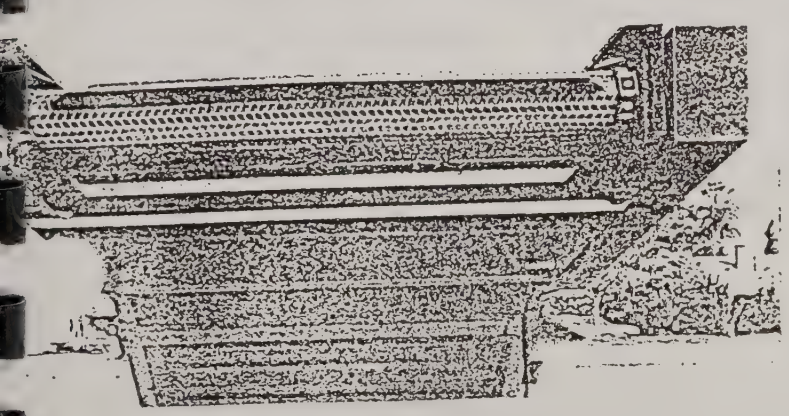
More Cleaning. Less Wear.

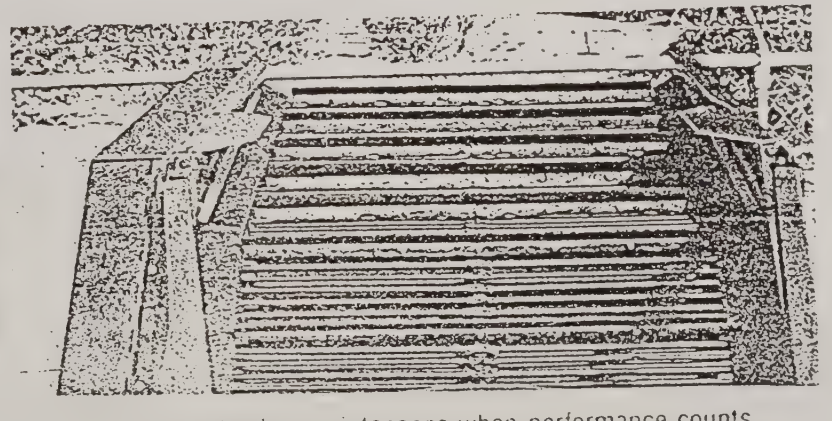
After 3 years of testing in dry and wet harvesting conditions these New Flory Harvesters are available! Both feature a 48" straight-thru 3 stage tumbling action that provides maximum dirt separation for superior cleaning performance!

Flory's proven pickup system and the 3,200 square inches of cleaning chain, ahead of the hi-volume suction fan, results in less fan wear, cleaner crops... and, a cleaner harvesting environment!

It's the new cleaning concept for the 90's that gives you the highest harvesting capacity anywhere for those big crops!

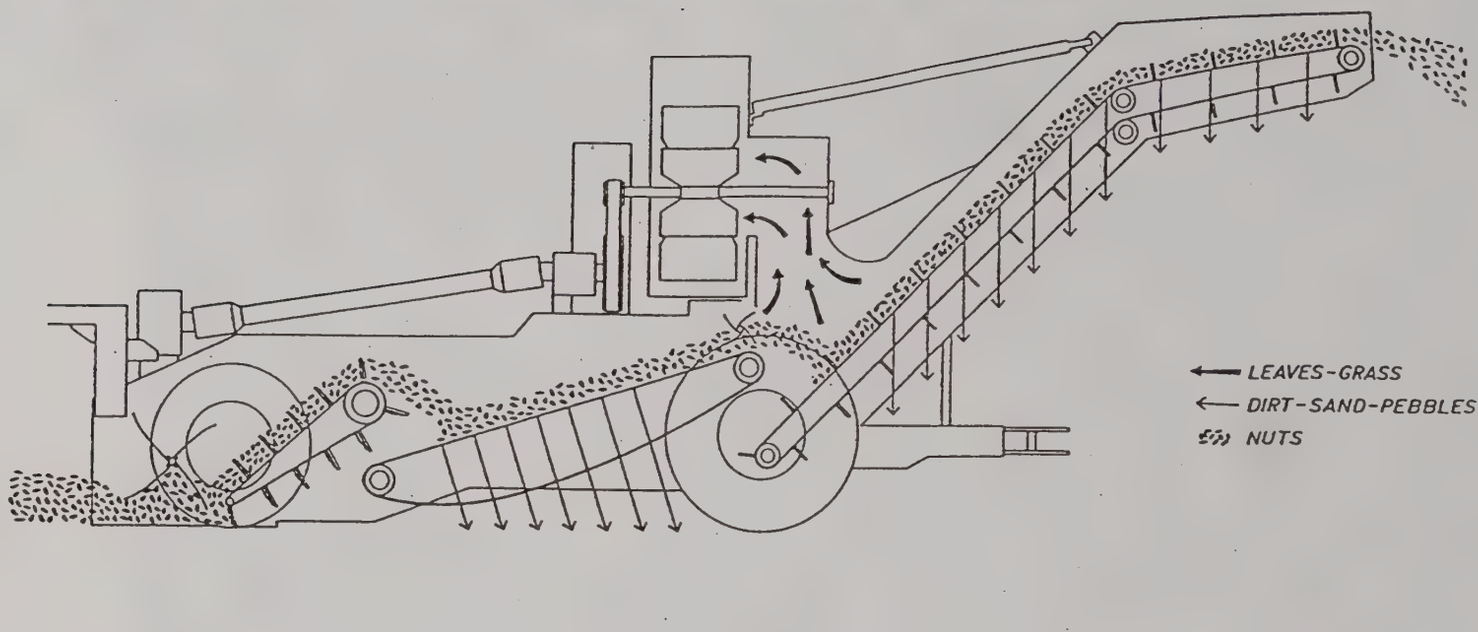
Contact Flory for all the harvesting facts that give you more performance and less maintenance. They're in great demand!

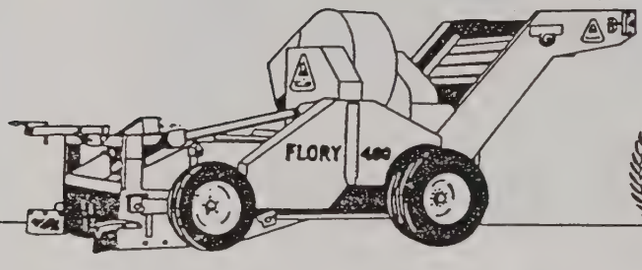




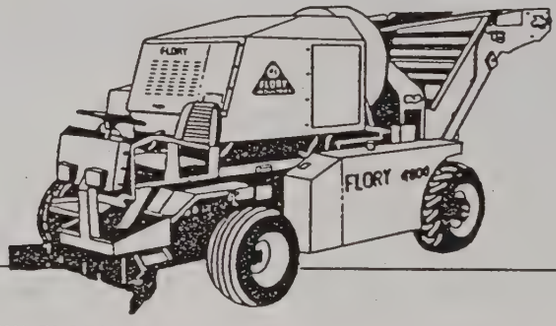
Flory's strong elevator construction with long life hi-capacity cleaning chains provides low maintenance when performance counts.

NEW Tri-Sep Cleaning Systems





50 ANNIVERSARY



THE NEW FLORY 480 P.T.O. HARVESTER

THE NEW FLORY 4800 SELF-PROPELLED HARVESTER

MODEL 480
SPECIFICATIONS

PICKUP WIDTH	48 IN.
CLEANING CHAIN WIDTH	48 IN.
OVERALL WIDTH	90 IN.
HEIGHT	81 IN.
LENGTH	19 FT.
WEIGHT	4,900 LBS.
FRONT TIRES	27 x 9.50 - 15
REAR TIRES	31 x 13.50 - 15
P.T.O. R.P.M.	540
MIN. H.P. - ALMONDS/WALNUTS	60
MIN. H.P. PECANS	80

OPTIONS

AUGER DRIVE KIT
HYDRAULIC HITCH KIT
FRONT SWEEP KIT

MODEL 480 - $22,700.00

MODEL 4800
SPECIFICATIONS

PICKUP WIDTH	48 IN.
CLEANING CHAIN WIDTH	48 IN.
OVERALL WIDTH	96½ IN.
HEIGHT	81 IN.
LENGTH	18 FT. 8 IN.
WEIGHT	9,000 LBS.
FRONT TIRES	26 x 12.00 - 12
REAR TIRES	31 x 15.50 - 15
FUEL CAPACITY	44 GAL.
ENGINE	4239T JOHN DEERE
H.P.	110
SPEED - LOW RANGE	0 - 6 M.P.H.
SPEED - HIGH RANGE	0 - 13 M.P.H.
AUXILIARY PUMP FLOW	15 G.P.M.
HYDRAULIC OIL CAPACITY	42 GAL.

OPTIONS

AUGER DRIVE KIT
HYDRAULIC HITCH KIT
FRONT SWEEP KIT

FLORY INDUSTRIES

P.O. Box 908 / 4737 Toomes Rd., Salida, CA 95368 / (209) 545-1167 / FAX: (209) 545-4924

A field proven Harvester in Performance and Quality.

The Flory 210 is quality constructed with heavy side plates and a strong frame. It is built to provide years of dependable performance with minimum downtime.

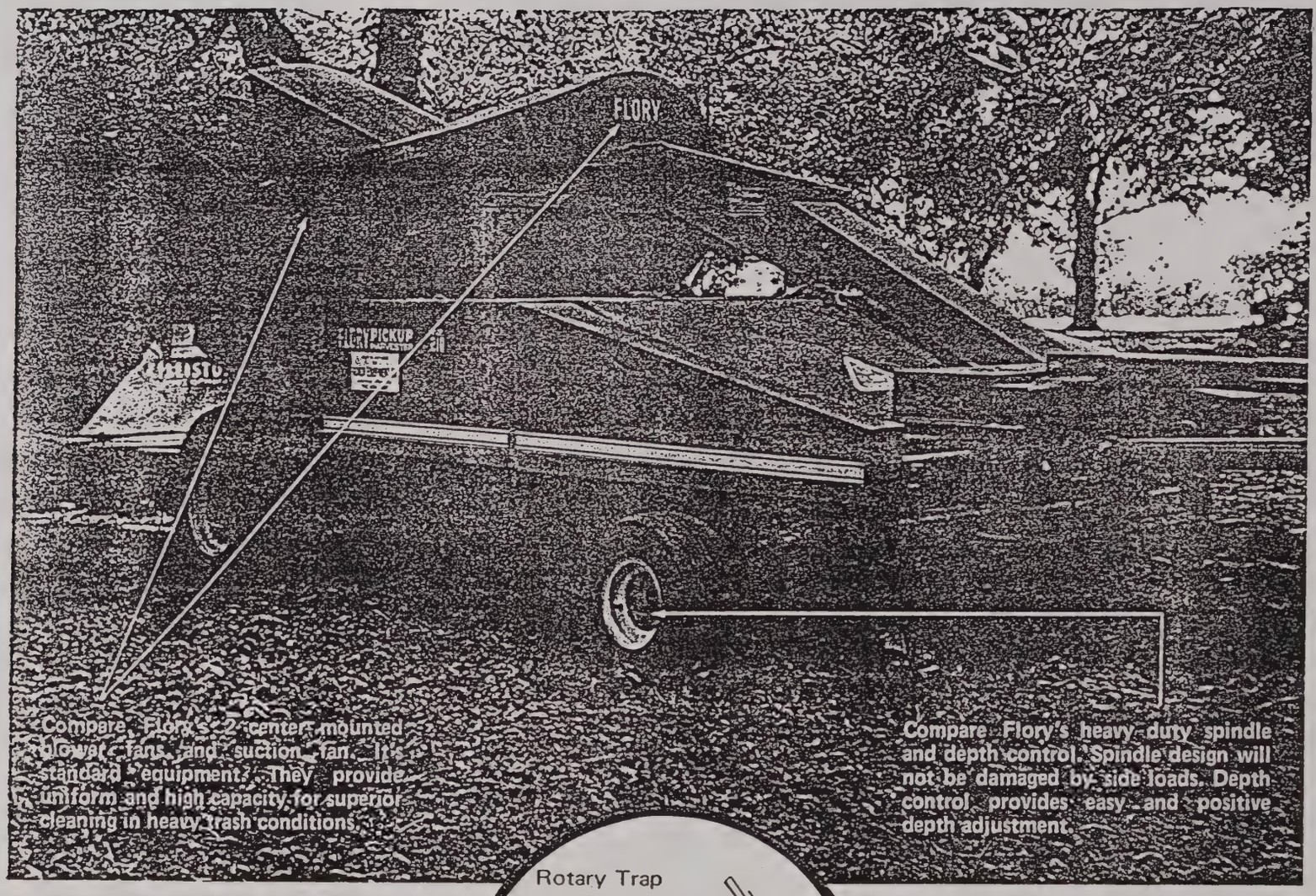
The adjustable tongue provides easy drive operation and maneuverability. Its pickup mechanism picks up nuts, even the tender, thin shell varieties with minimum crackage. With its adjustable depth control and unique pickup system and rotary trap, the Flory 210 picks up clean and eliminates large piles of nuts at the end of windrows.

The 210 high capacity suction and blower fans take trash, twigs, leaves, etc. out of your harvest.

The Flory 210 tractor powered harvester is designed to provide superior pickup quality on hilly as well as level terrain.

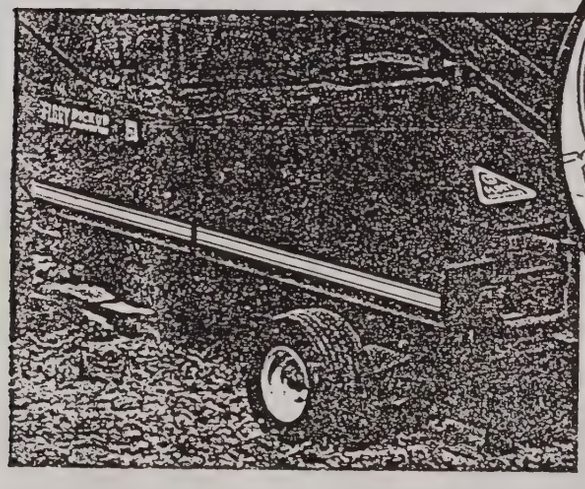
Ask for a field demonstration in your orchard with a Flory 210.

FI
FLORY
INDUSTRIES

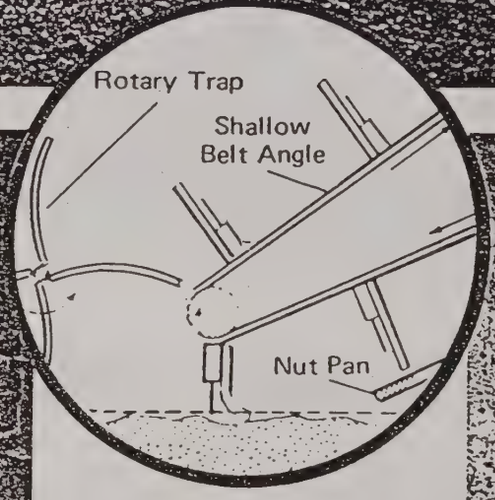


Compare Flory's 2 center mounted blower fans and suction fan. It's standard equipment. They provide uniform and high capacity for superior cleaning in heavy trash conditions.

Compare Flory's heavy duty spindle and depth control. Spindle design will not be damaged by side loads. Depth control provides easy and positive depth adjustment.

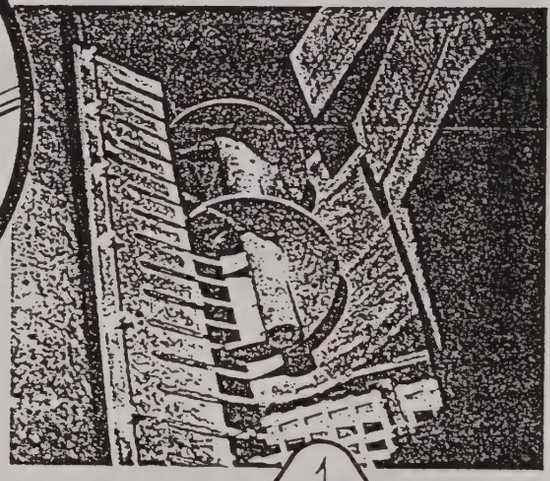


Compare Flory's hinged safety shields. They give you maximum accessibility for service and safe operation.



THE HEART OF ANY PICK-UP HARVESTER IS THE PICK-UP SYSTEM

REDUCES NUT CRACKAGE COMMON WITH OTHER SYSTEMS.



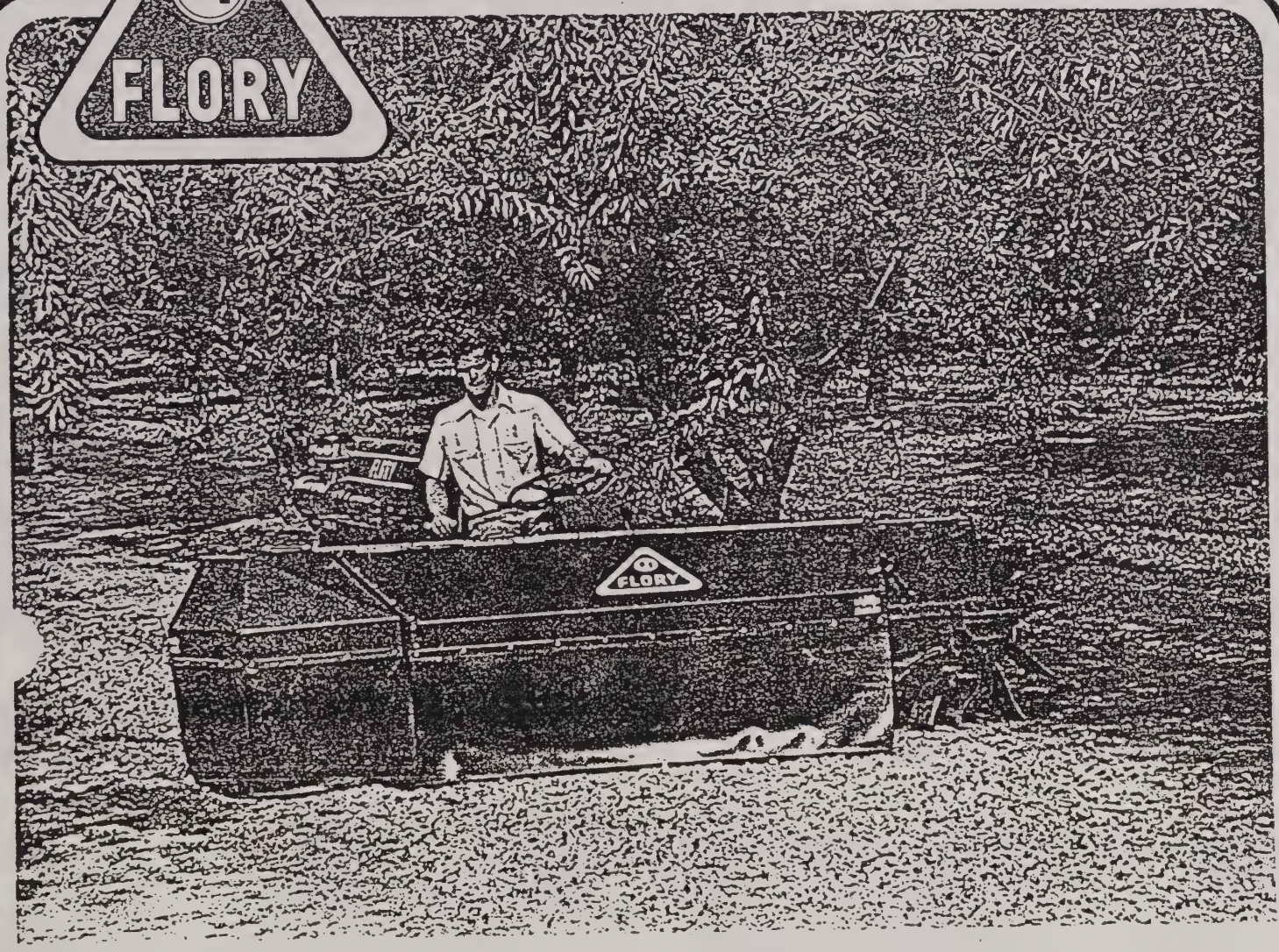
Compare Flory's free-flow auger. It prevents clogging and eliminates costly crop as well as equipment damage.

PROFIT FROM FLORY PERFORMANCE

FLORY INDUSTRIES

P.O. Box 908 - 4737 Toomes Rd.
Salida, California 95368
(209) 545-1167

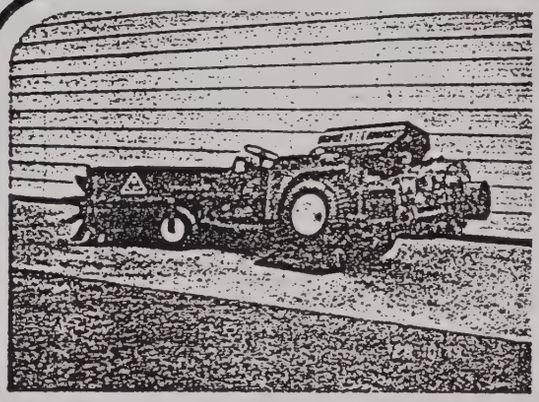
THE FLORY 50 SERIES SWEEPER
...sweeping the country.



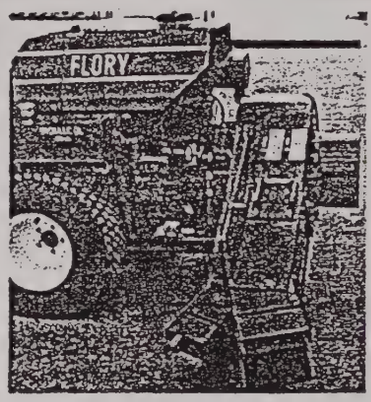
In over 25 years of building sweepers... the Flory 50 Series Sweeper has come to the ultimate in crop recovery with the maximum in sweeping performance! This heavy duty sweeper provides more blowing power for those rugged and hard-to-get-at places. It not only sweeps with ease in heavy leaf and trash conditions, but the variable reel drive allows you to increase the reel speed for heavier going and faster sweeping when our crop is *on the ground!* The Flory 50 Series Sweeper with high flotation tires... allows you to sweep on even or uneven terrain under adverse soil conditions. Flory's 5 bar reel reduces tooth speed for cleaner sweeping as well as prolonging teeth life resulting in effective sweeping on all types of nuts. These Flory fuel efficient, and low maintenance self-propelled sweepers, have lowered harvesting costs, which have raised profits for growers throughout the World!

FLORY. SWEEPING THE COUNTRY.

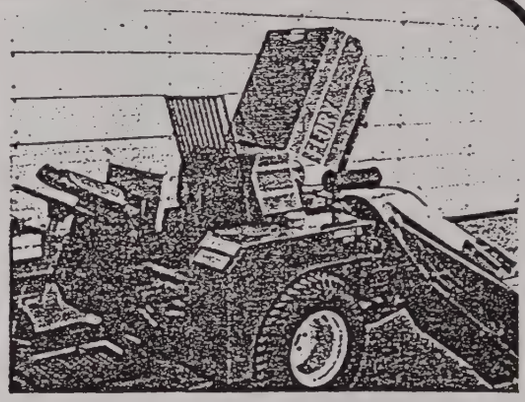
HOW THE FLORY 50 SERIES SWEEPER
Performs for You...



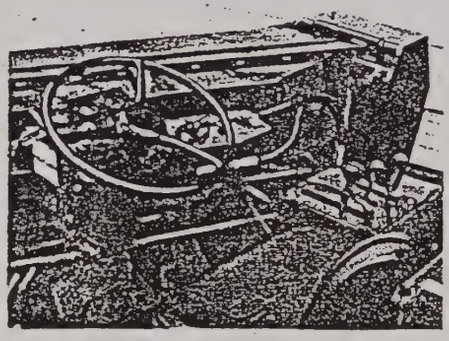
Flory's Suspension System and unique patented sweeping head keeps head level with ground, even with wheels on a steep angle.



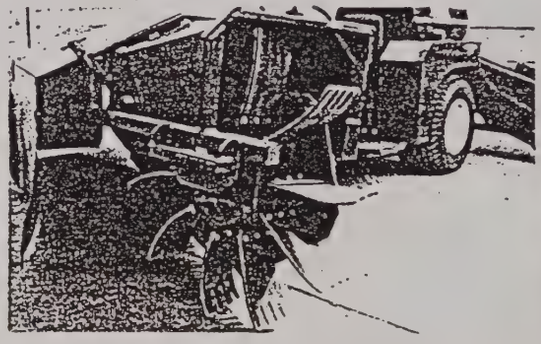
Large Blower Fan with Multi-adjustable outlet spouts provide superior and efficient blowing.



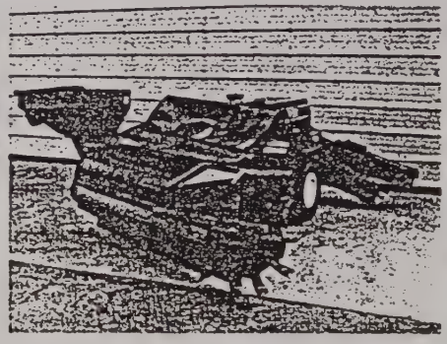
Hinged Seat and Engine Cover plus removable grill allows easy access for service.



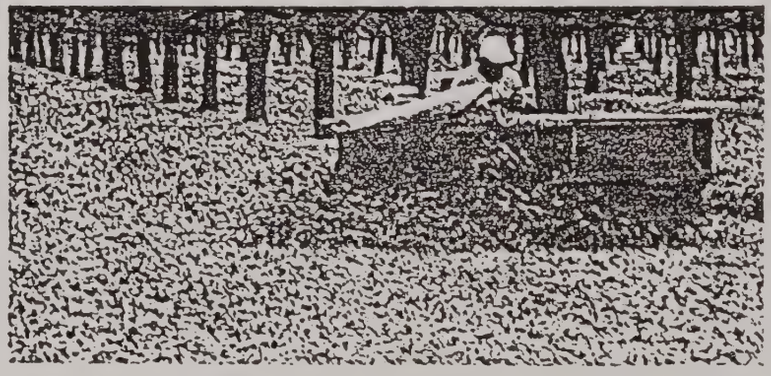
Foot Operated Head-lift and Finger Tip Controls for operator convenience and safety.



"Align-mount Reel" provides self-alignment for longer bearing and reel life along with variable hydraulic drive.



The Hinged Reel Covers allow for a smoother crop flow and easy access.



The Flory Model 7050 features a large diameter sweeping head. Ideal for heavy leaf and trash conditions. A proven performer in Pecan sweeping.

SPECIFICATIONS:

ENGINE - 4 Cylinder Kubota Water Cooled Diesel
WEIGHT - 2,650 Lbs. (Model 7650)
LENGTH - 13 Feet, 5 Inches (Model 7650)
HEIGHT - 44 Inches (All Models)
SWEEPING WIDTHS - 6650: 6 Feet, 6 Inches
7650: 7 Feet, 6 Inches
8650: 8 Feet, 6 Inches
7050: 7 Feet
FUEL CAPACITY - 15 Gallons
HYDRAULIC OIL CAPACITY - 12 Gallons
SPEED - 0-10 M.P.H.
OPTIONS: Light Kit, Branch Guard
Blower Spout with Hydraulic Height Control

P.O. BOX 908 / 4737 TOOMES RD., SALIDA, CA 95368
(209) 545-1167 / FAX: (209) 545-4924

FLORY INDUSTRIES

model 7650 - $25,500.00

MORE VALUE FOR YOUR INVESTMENT / HARVEST

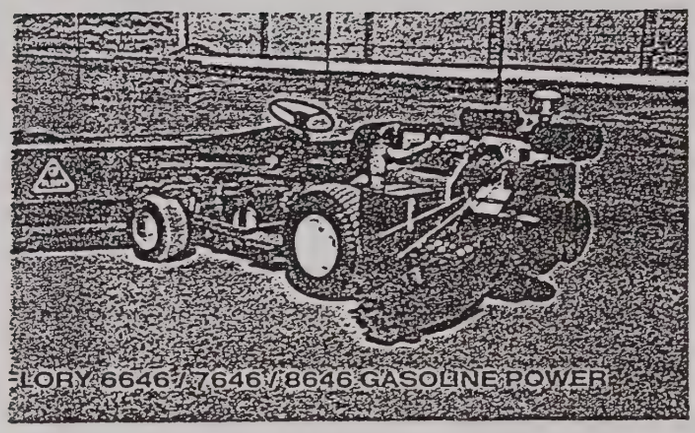
Flory 46 Series Gas / Diesel Sweepers.

The heavy duty Flory 46 Series Gasoline and Diesel Sweeper Series give you the most blowing power for rugged and hard-to-get at places. They sweep with ease in heavy leaf and trash conditions. The variable hydraulic reel drive allows you to increase the reel speed for heavier going and faster harvesting.

They feature high flotation tires to allow you to work in even or uneven terrain under adverse soil conditions. The Flory patented 5 bar sweeping reel reduces tooth speed for better sweeping. Provides prolonged teeth life and results in effective sweeping on all types of nuts, tenderly . . . and gently. The Flory Self-Propelled Heavy Duty Sweepers have lowered harvesting costs and raised profits for Growers throughout the World. They are the standard for the Industry. Another Flory Story of Innovation. Flory . . .

50 ANNIVERSARY 1936-1986

serving the Agricultural Industry Since 1936.



FLORY 6646 / 7646 / 8646 GASOLINE POWER

Models 6646-KD / 7646-KD and 8646-KD Diesel Power
2 Year Warranty

THE FLORY 6646 / 7646 and 8646 GASOLINE and DIESEL SWEEPERS FEATURE QUALITY ENGINEERING. MAKES THE BIG PROFIT DIFFERENCE.

SPECIFICATIONS

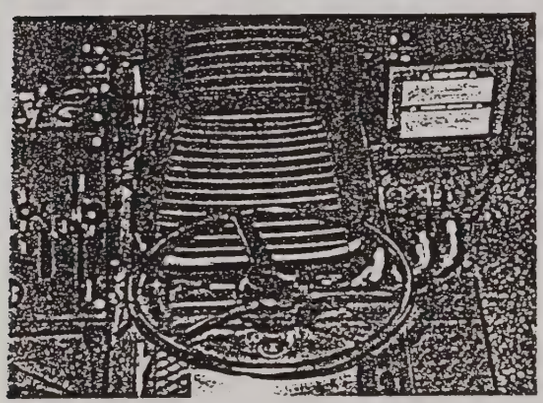
Models 6646 / 7646 / and 8646 Gasoline Power

- ENGINE - 35 H.P. Wisconsin Model W-4 air cooled
- SWEEPING WIDTHS
  - 6646 6 ft. 6 in.
  - 7646 7 ft. 6 in.
  - 8646 8 ft. 6 in.
- ADJUSTABLE BLOWER OUTLETS
- FUEL CAPACITY — 14.5 gallons
- HI-CAPACITY, 3 STAGE AIR FILTRATION SYSTEM
- LARGE BLOWER FAN
- VARIABLE BLOWER FAN CONTROL
- DUAL WHEEL PARKING BRAKES

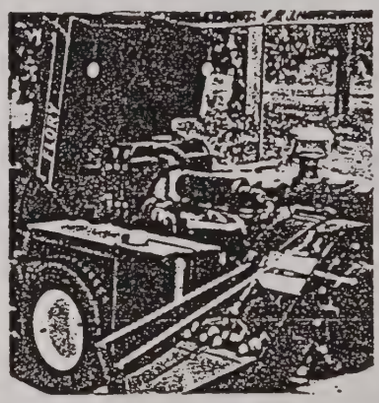
Models 6646-KD / 7646-KD and 8646-KD Diesel Power

- ENGINE - 33 H.P. Kabota water cooled
- SWEEPING WIDTHS
  - 6646-KD 6 ft. 6 in.
  - 7646-KD 7 ft. 6 in.
  - 8646-KD 8 ft. 6 in.
- ADJUSTABLE BLOWER OUTLETS
- FUEL CAPACITY — 14.5 gallons
- HI-CAPACITY, 3 STAGE AIR FILTRATION SYSTEM
- LARGE BLOWER FAN
- VARIABLE BLOWER FAN CONTROL
- DUAL WHEEL PARKING BRAKES
- POWER STEERING

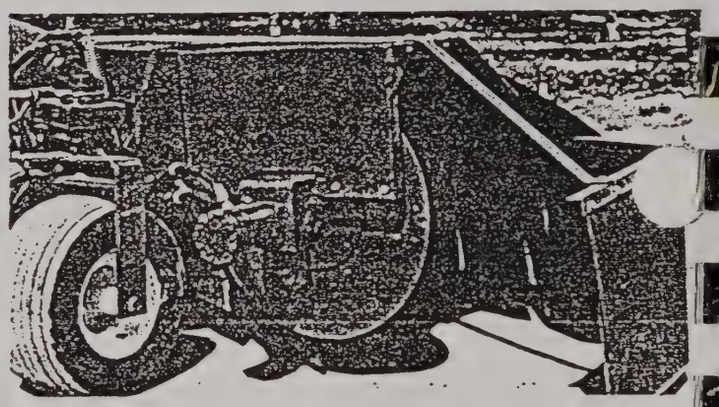
OPTIONS —
- BRANCH GUARDS
- ENGINE COVER (gas)



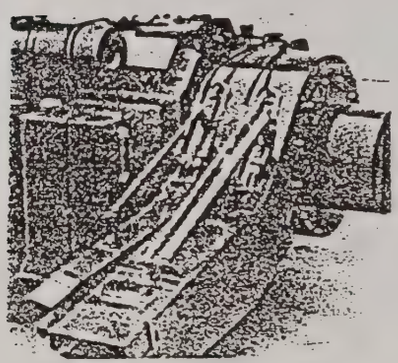
.ORY'S SELF-PROPELLED SWEEPERS place controls for ıger-tip Operator Convenience and Safety.



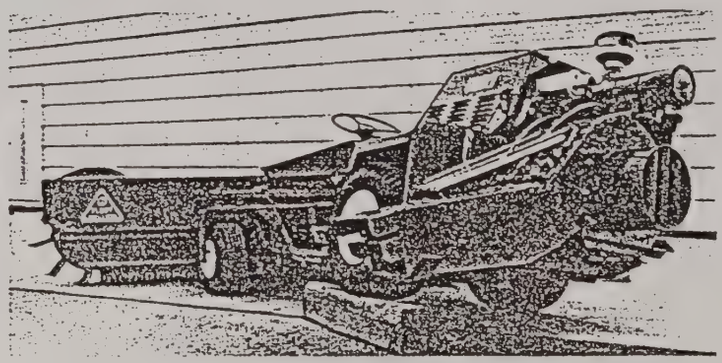
THE HINGED ENGINE COVER provides ease of service.



THE FLORY HYDRAULIC REEL DRIVE allows variable reel speeds for various sweeping conditions. Eliminates belts and sheaves for added Operator Protection.



FLORY'S UNIQUE LARGE EFFICIENT BLOWER FAN provides superior hi capacity tree row cleaning with variable air control.



FLORY'S SUSPENSION SYSTEM and unique patented sweeping head keeps head level with ground, even with wheels on steep angle

PROFIT FROM FLORY PERFORMANCE

FLORY INDUSTRIES

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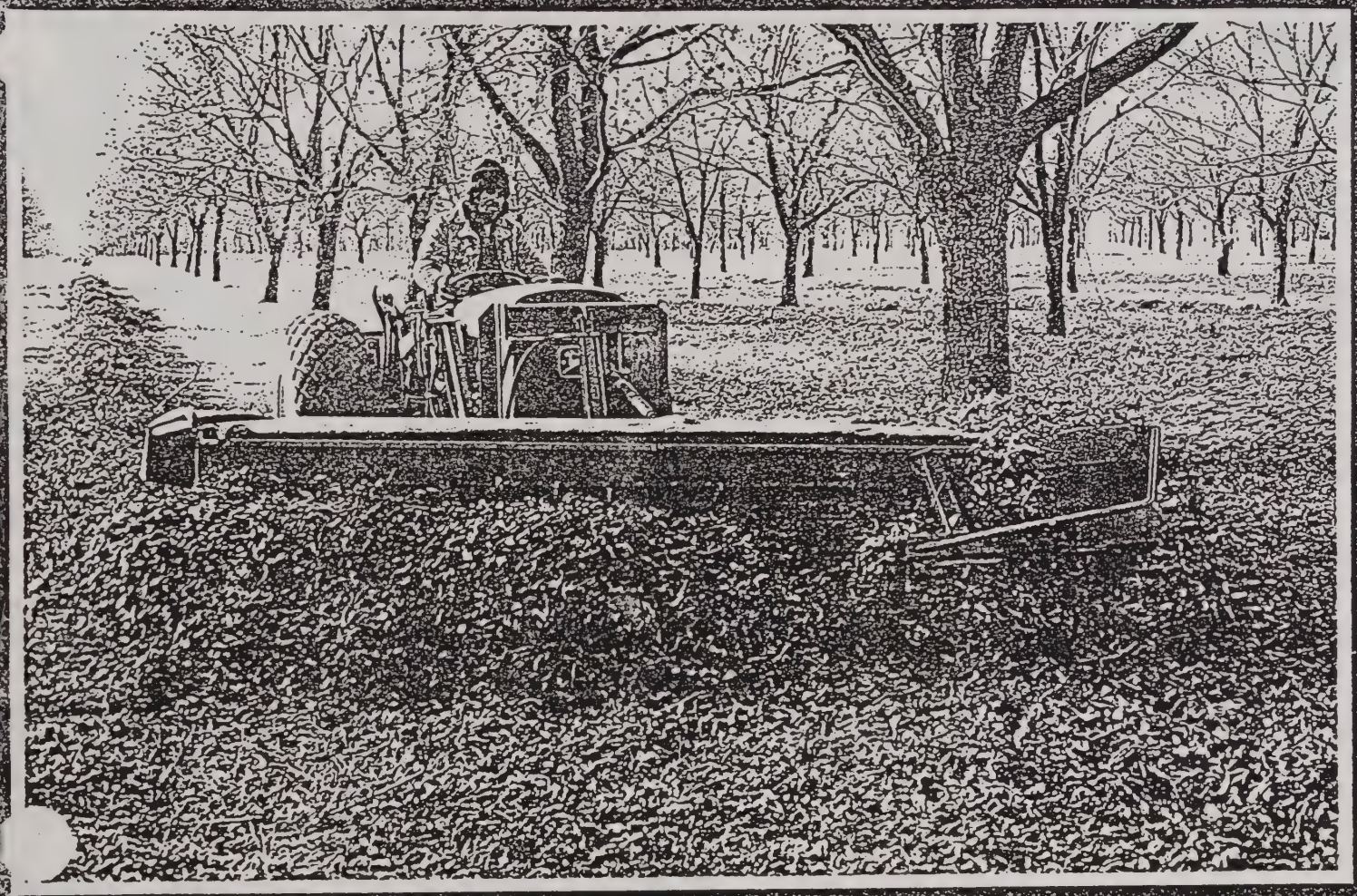
SALIDA, CA 95368/(209)545-1167
Fax: (209) 545-4924

FLORY 9800/9810



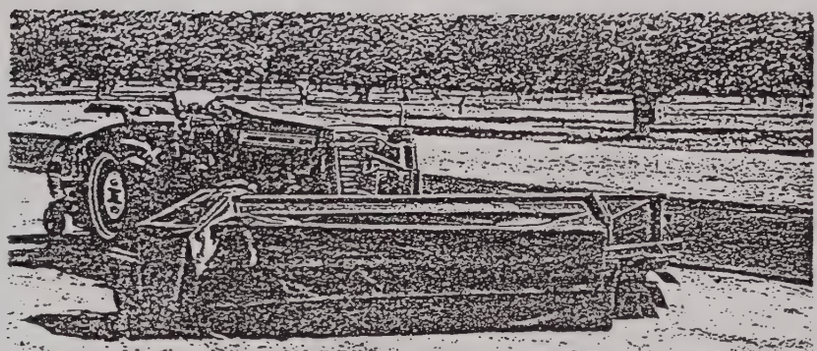
The Flory Tractor Mount Sweeper and Blower.

The Flory 9800/9810 Sweeper Series add 2500 Blower is used for walnuts, almond, pecan and fig orchards. It provides fast, effective sweeping and blowing in heavy trash conditions. The reel type sweeping head has proven superior in loose and sandy soils and in heavy grass. Its design is unique. It is available with a self-contained hydraulic system, which eliminates the need for additional mountings of pumps, etc. Flory Quality above all. Ask for a demonstration today!

Superior sweeping and cleaning for tough conditions.

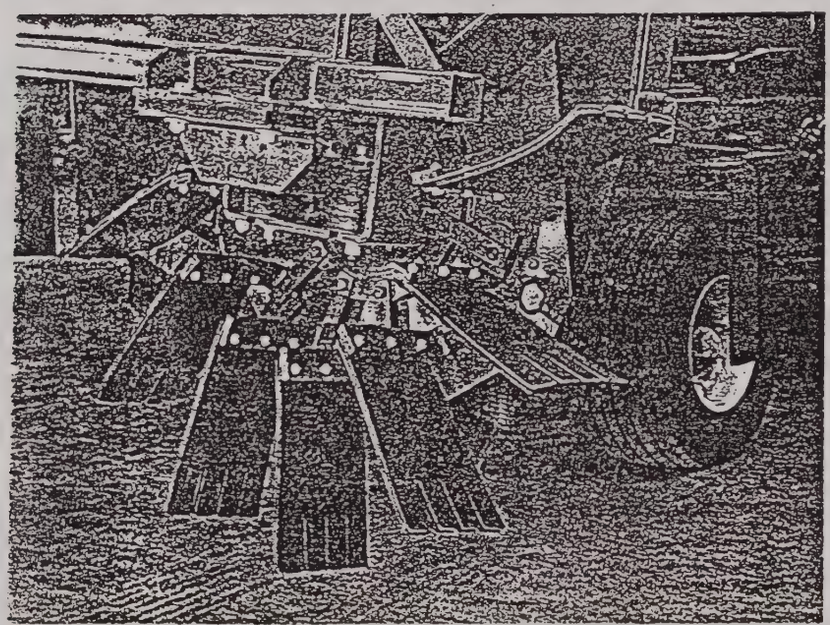
QUALITY ABOVE ALL.

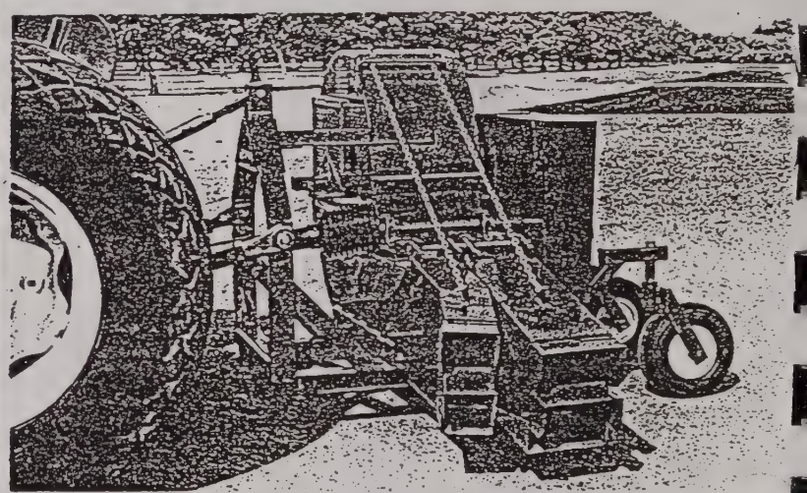
FLORY INDUSTRIES



ONE MAN...ONE TRACTOR for sweeping and blowing. The Flory Model 9800/9810 Sweeper Series and the Model 2500 Blower are easy for one man to connect and disconnect within minutes with the 3 point hitch and drive shaft hook-up. The simplicity of design, operator convenience and minimum maintenance make the big profit difference in orchards. **The Model 9800/9810 Sweepers** feature 8½' and 10' sweeping widths. The Flory 5 bar reel is the result of extensive research and testing in comparison to additional bars. The 5 bar reel has proven to sweep cleaner while reducing teeth interference wi each other. And, it reduces costly bearings and additional teeth replacements! **The Model 2500 Blower** provides superior power and performance for high capacity cleaning. It makes a clean tree row in tough harvesting conditions. Profit from the Flory Model 9800/9810 Sweepers and Model 2500 Blower in your orchards. **Quality with performance above all.**

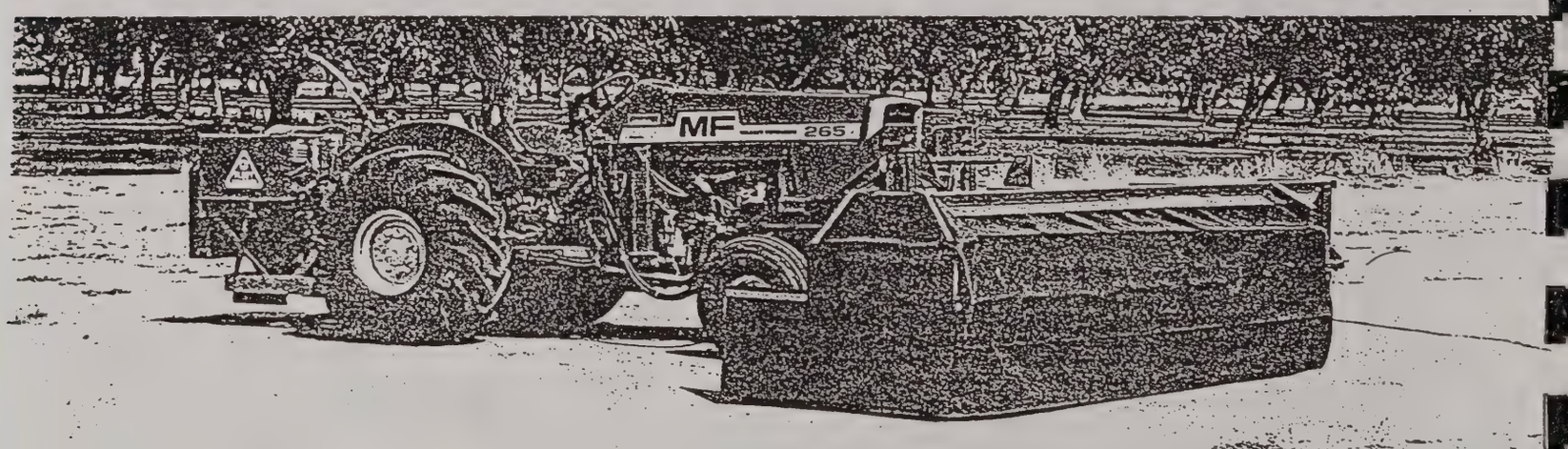
HE FLORY HYDRAULIC REEL DRIVE allows variable reel speeds for arious sweeping conditions. Which means a Flory Sweeper fulfills your veeping requirements.





E FLORY UNIQUE "ALIGN-MOUNT" REEL allows flexibility of reel in the me. Provides self-alignment reducing bearing and reel failure when structions are encountered during sweeping.

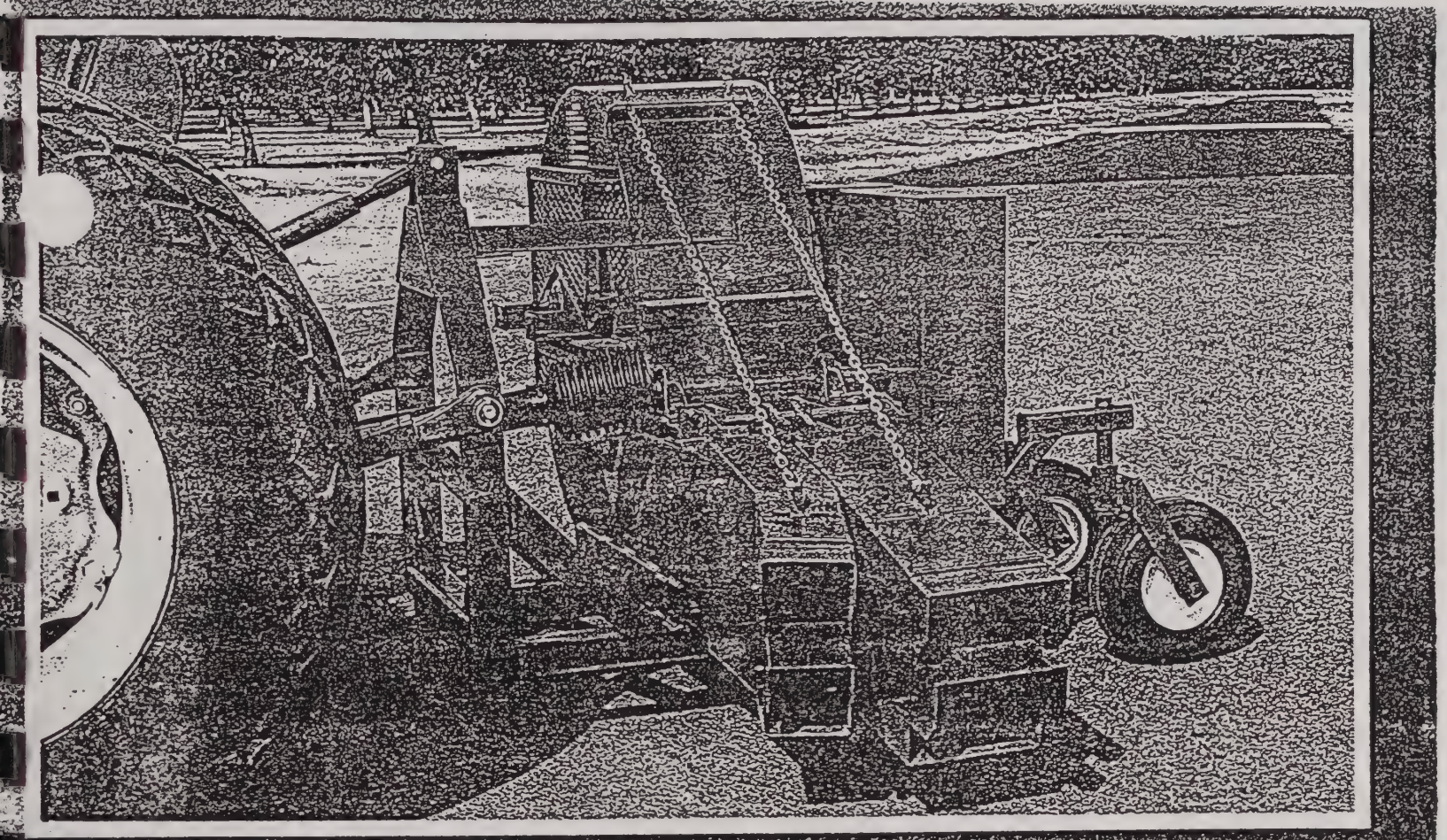
THE FLORY BLOWER is controlled with a damper and cylinder which all variable amount of air without effecting the R.P.M. of the tractors' engine. ... flow direction is adjustable. Its depth wheels allow the blower to follow the ground contour.



HE FLORY 9800/9810 SWEEPER HEAD and the MODEL 2500 LOWER float independently of the tractor for a cleaner sweep in uneven errain. The Flory Tractor Mount Sweeper and Blower was designed for rowers who want superior performance.

FLORY INDUSTRIES

P.O. Box 908
4737 Toomes Road
Salida, CA 95368
(209) 545-1167



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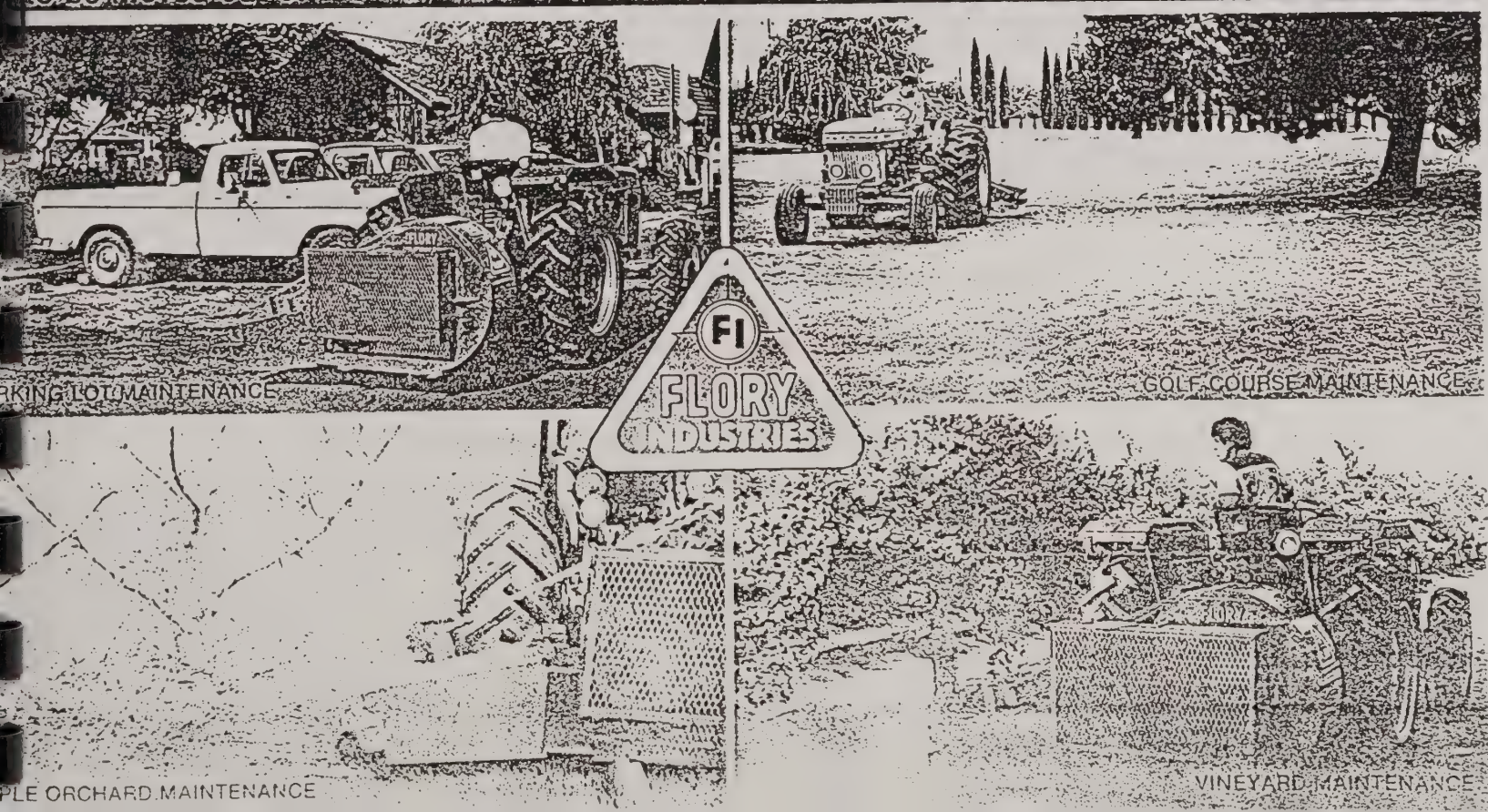

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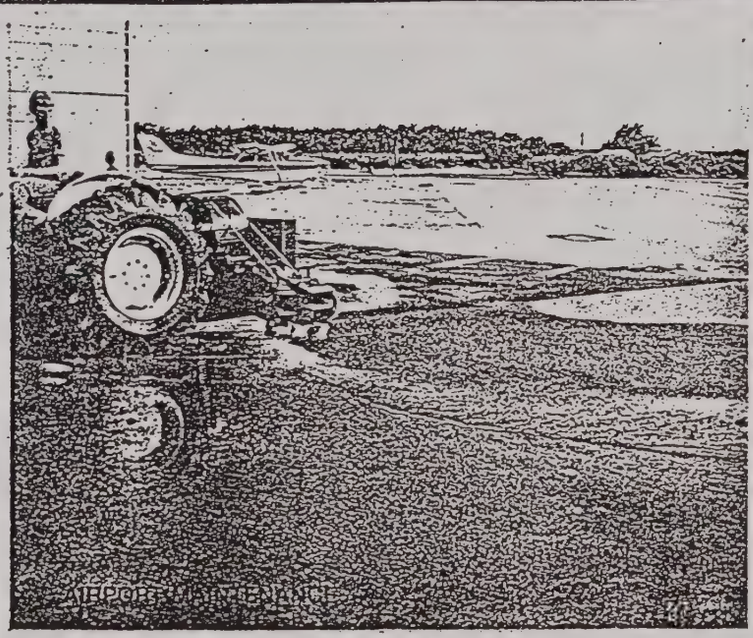
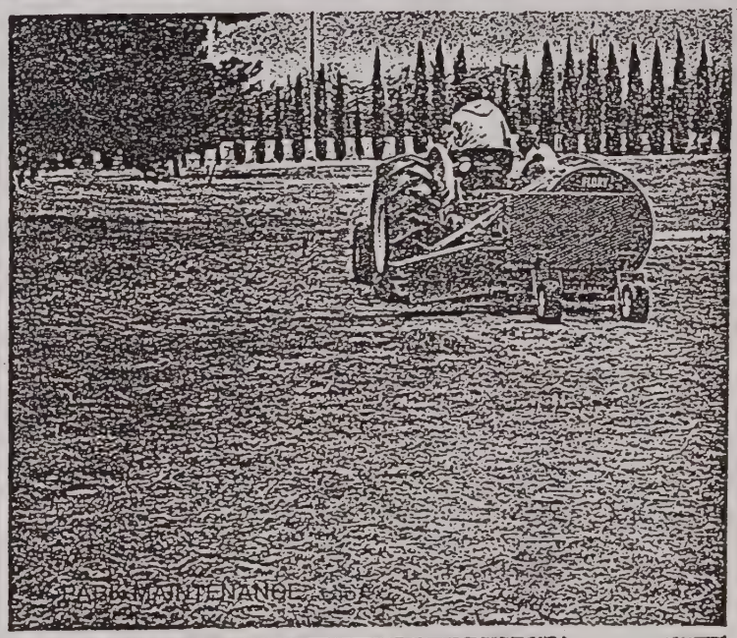


AIRPORT MAINTENANCE



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6650 - 6'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	$25,500.00
7650 - 7'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	25,700.00
8650 - 8'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	25,900.00
7050 - 7'	LARGE DIAMETER HEAVY-DUTY TINE BAR HEAD	25,900.00
70 SERIES S.P. SWEEPER WITH 4 CYL. 4239 JOHN DEERE DIESEL WITH BRANCH GUARD		
6670 - 6'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	$31,900.00
7670 - 7'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	31,900.00
8670 - 8'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	32,100.00
7070 - 7'	LARGE DIAMETER HEAVY-DUTY TINE BAR HEAD	32,100.00
70 SERIES S.P. SWEEPER WITH 4 CYL. 4239 JOHN DEERE DIESEL WITH AIR CAB		
6670 AC - 6'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	$36,900.00
7670 AC - 7'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	36,900.00
8670 AC - 8'6"	LOW PROFILE HEAVY-DUTY TINE BAR HEAD	37,100.00
7070 AC - 7'	LARGE DIAMETER HEAVY-DUTY TINE BAR HEAD	37,100.00
9800 - 8'6"	LARGE DIAMETER TRACTOR MOUNT	9,400.00
9810 - 10'	LARGE DIAMETER TRACTOR MOUNT	9,900.00
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480-P	PTO	PECAN HARVESTER WITH 48" ELEVATOR	- 25,200.00
7480-A	S.P.	ALMOND HARVESTER WITH 48" ELEVATOR	- 56,500.00
7480-W	S.P.	WALNUT HARVESTER WITH 48" ELEVATOR	- 57,500.00
7480-P	S.P.	PECAN HARVESTER WITH 48" ELEVATOR	- * 59,900.00
1180	TANDEM AXLE SUPER-CART		- 5,900.00
1180-S	SINGLE AXLE SUPER-CART		- 5,250.00
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Appendix C

Letter to Dir, FPM - Committee's
1994 and 1995 Technology
Development Recommendations

United States Department of Agriculture | Forest Service | FHTET - Davis | 2121 C Second Street
Davis, CA 95616
PH (916) 757-8341
FAX (916) 757-8383

File Code: 3400
Route To:

Date: July 19, 1995

Subject: Technology Development Needs - Seed, Cone, and Regeneration Insects

To: Director, Forest Health Protection

The National Steering Committee for Managing Seed, Cone, and Regeneration Insects met at Coeur d'Alene, ID, July 11-13, 1995, and reviewed technology development needs. The committee ranked each need with consideration to national needs within federal, state, and private forestry operations. The technology development needs are listed by a priority with number 1 the highest priority.

1. Conduct pilot tests of synthetic nicotines, (Admire, Merit, and Gaucho), in seed orchards and plantations.

2. Develop a risk-rating system for western pineshoot borer in lodgepole pine and ponderosa pine.

3. Demonstrate and evaluate the "trap-out" potential of pheromone-based mass-trapping of cone beetles in eastern white pine and seed orchards.

4. Pursue single tree spray systems by evaluating reduction of volume, increasing tree coverage, and improving efficacy of application in orchards and wild stands.

/s/ John W. Barry

JOHN W. BARRY
Director, FHTET-Davis

cc: Committee Members
Nancy Lorimer
Directors, FHTET

United States Department of Agriculture | Forest Service | Washington Office | 2121 C Second Street
Davis, CA 95616
PH (916)551-1715
FAX (916)757-8383

Reply To: 3400

Date: July 18, 1994

Subject: Technology Development Needs - Seed, Cone, and Regeneration Insects

To: Mel Weiss, Acting Director, FPM

The National Steering Committee for Managing Seed, Cone, and Regeneration Insects met in Rhinelander, WI, June 28-30, 1994 and identified several technology development needs. The committee ranked each need equally and noted those of national importance to state, federal, and private land managers. The technology development needs submitted by the committee are listed:

- Develop a risk-rating system for western pineshoot borer in lodgepole pine and ponderosa pine.
- Perform exclusion assays to determine insect role in conelet abortion and seed yield in white bark pine and western white pine.
- Demonstrate and transfer IPM technology for seed bugs and coneworm. Included is a degree-day evaluation for seed bugs.
- Further single tree spray system by evaluating reduction of volume, increasing tree coverage, and improving efficacy of application. Transfer technology including applications in urban forestry.
- Evaluate Asana XL in northern red oak orchards to control flower and acorn insects.
- Conduct pilot tests of synthetic nicotines, (Admire, Merit, and Gaucho), in seed orchards.
- Develop non-chemical alternatives to control Douglas-fir cone gall midge and white-pine cone beetle.
- Demonstrate and evaluate the "trap-out" potential of pheromone-based mass-trapping of cone beetles in eastern white pine and seed orchards.

/s/John W. Barry
JOHN W. BARRY
Chair

cc: Members, Steering Committee

Appendix D

White Paper - "The Role of the Forest Service in Seed Orchard Pest Management Research" and associated correspondence

The Inland Empire
Tree Improvement Cooperative

Office of the Director
Telephone 208 885-7920
Fax 208-885-6226
Fax 208-885-6564

May 3, 1995

Bob Weir
North Carolina State University
Tree Improvement Program
Box 8002
Raleigh, NC 27695-8002

Dear Bob:

The Inland Empire Tree Improvement Cooperative (IETIC) represents all of the major forest land management organizations in the inland northwestern United States and one private industrial firm in British Columbia, a total of nearly 16MM acres of forest land. On behalf of the members of the Steering Committee of the IETIC, I am writing this letter in support of the SFTIC Position Paper on "The Role of the Forest Service in Seed Orchard Pest Management Research".

We find the paper to be an excellent and balanced review of the seed orchard research question and support the conclusions that "Forest Service scientists are needed to ensure that the genetically improved material for reforestation can be efficiently produced" and that "Seed orchard pest management is economically and environmentally important, and should receive strong support." We note, particularly, that research on insect biology, biological control of insects and "environmentally friendly" insecticides, all have the potential to result in information that can be used to maintain and enhance forest health as well as forest productivity. Such studies will be critical to efficient, long-term management of our forests.

We thank you and your committee for your excellent work on this position paper.

Very truly yours,

Lauren Fins
Director, IETIC

Northwest Tree Improvement Cooperative

AFFILIATED WITH WESTERN FORESTRY AND CONSERVATION ASSOCIATION
Represented by Daniels & Associates, Inc., Forest Genetics Consultants
and Regenetics Forest Genetics Consulting

DIRECTOR'S OFFICE:
DANIELS & ASSOCIATES, INC.
1143 West Roanoke Street
Centralia, WA 98531–2023
Phone & Fax (360) 736–1228

GENETICIST'S OFFICE:
REGENETICS
848 Northeast 56th Street
Seattle, WA 98105–2729
Phone & Fax (206) 524–8380

May 11, 1995

Dr. Robert Weir
NC State University Tree Improvement Program
Box 8002
Raleigh, NC 27695-8002

Dear Dr. Weir:

The Northwest Tree Improvement Cooperative (NWTIC) has 36 members, including the USDA Forest Service, USDI Bureau of Land Management, and six Canadian organizations (see enclosed list). At the March 1 Annual Membership Meeting, Chuck Masters (Weyerhaeuser) presented the position paper developed by the SFTIC Seed Orchard Pest Management Subcommittee, and he asked for NWTIC's support of this effort. All members were subsequently asked to read the paper and to fill out a simple survey indicating their support.

I would like to inform you that NWTIC does support the position paper. However, federal agencies and Canadian organizations feel that it is inappropriate for them to take a position on this issue and have abstained from voicing their opinion.

Please call me at (360 or 206) 736-1228 if you have any questions.

Sincerely,

Jess D. Daniels, NWTIC Director

D:\COOPS\LETTERS\SFTICDEW.LTR
Enclosure
cc: NWTIC Steering Committee

NW-5
4/95

Northwest Tree Improvement Cooperative

AFFILIATED WITH WESTERN FORESTRY AND CONSERVATION ASSOCIATION
Represented by Daniels & Associates, Inc., Forest Genetics Consultants
and Regenetics Forest Genetics Consulting

DIRECTOR'S OFFICE:
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GENETICIST'S OFFICE:
REGENETICS
848 Northeast 56th Street
Seattle, WA 98105–2729
Phone & Fax (206) 524–8380

CURRENT MEMBERSHIP

Avery Interests
Boise Cascade Corp.
Canadian Forest Products, Ltd.
Cascade Timber Consulting, Inc.
Cavenham Forest Industries Division
Champion International Corp.
Crown Pacific, Ltd.
Davidson Industries, Inc.
Fred M. VanEck
Hampton Tree Farms, Inc.
International Paper Co.
John Hancock Mutual Life Insurance Co.
Longview Fibre Co.
MacMillan Bloedel, Ltd.
Medite Corporation
Menasha Corporation
Miami Corporation
Oregon Department of Forestry
Pacific Forest Products, Ltd.
Plum Creek Timber Co.
Pope Resources
Port Blakely Timber Co.
Province of British Columbia Ministry of Forests
Quinault Indian Nation
Rayonier Timberlands Operating Co.
Simpson Timber Co.
South Coast Lumber Co.
Starker Forests, Inc.
Stimson Lumber Co.
TimberWest Forest, Ltd.
University of Washington - Pack Forest
USDA Forest Service - PNW Research Station
USDA Forest Service - R-6
USDI Bureau of Land Management
Western Forest Products, Ltd.
Willamette Industries, Inc.

The Role of the USDA Forest Service in Seed Orchard Pest Management Research & Development

A Position Paper of the
Southern Forest Tree Improvement Committee

February 20, 1995

Endorsed by:
The Inland Empire Tree Improvement Cooperative
The Northwest Tree Improvement Cooperative

The Role of the USDA Forest Service in Seed Orchard Pest Management Research & Development

A Position Paper of the Southern Forest Tree Improvement Committee

Introduction

The Southern Forest Tree Improvement Committee (SFTIC) represents the community of forest geneticists and tree breeders in the southern US, including three southern forest tree improvement cooperatives with a combined membership of 47 industrial organizations and state agencies across the 12 southern states. SFTIC organized the Seed Orchard Pest Management Subcommittee (SOPMS) in 1989, to coordinate region-wide research and development in orchard pest management. The SOPMS also has members representing state agencies and private industry in the western US.

This paper presents our views on how the Forest Service should be involved in research, technology development, and technology transfer in seed orchard pest management. We will discuss the following topics:

- the diminishing federal contribution to timber supply in the US,
- the need to increase productivity of state and private forest lands,
- the value and on-going nature of tree improvement programs,
- the role of seed orchards and seed orchard pest management in the production of genetically improved material,
- the responsibility of the Forest Service to provide leadership for the Nation's forestry community,
- the historic role of the Forest Service in seed orchard pest management research, and
- the research needed today in the area of seed orchard pest management.

In summary, it is our opinion that it is important to the Nation that the Forest Service continue its historically strong support of seed orchard pest management research.

Timber Supply: The Productivity Challenge

In recent years, changing public opinion regarding the function of federally owned forest lands has led to significant reductions in timber offered for sale by the Forest Service. Timber offered for sale has declined for three consecutive years, with the amount offered in 1993 (4.6 billion board feet) less than half the amount offered in 1990 (12 billion board feet). If current levels are maintained, or continue to decline, the amounts will be well less than half the amounts recommended in the 1990 Resources Planning Act for the years 1995 through 2040[1]. The decreased harvest has had a heavy impact on Western states; for example, in the state of Oregon, federal timber contributed 3-4 billion board feet per year to the annual harvest from 1983 to 1987, but based on current timber sales, the federal contribution has dropped to about 400 million board feet per year[2]. **The reduction of timber harvests on federal lands has placed increased demands on private forest lands (both in the west and the south) to be more productive.** The pressure to be more productive on less land will increase even more in the future if state governments withdraw lands from timber production, or adopt stringent regulations on forest management. If the demand for wood is not met domestically, the US will need to rely increasingly on imports, possibly increasing pressure to exploit world forests that are less well managed and more environmentally sensitive than ours. If private forest lands in the US are to make up the difference, genetic gains from tree improvement programs will be crucial. However, these genetic gains can only be realized if there is effective pest protection in the seed orchards where genetically improved seed is produced.

It is evident that federally-owned forest lands are being withdrawn from timber production in favor of other natural resource goods and services. **It is our opinion, that in response to this situation, the role of the Forest Service in production-oriented research and technology development should not be decreased, but actually be increased.** Additional efforts by the Forest Service to improve productivity on state and private lands dedicated to timber production will aid in accomplishing one of its mandated goals of keeping our Nation's forest lands fully productive. In particular, we recommend strong support of Forest Service programs focused on management of seed orchard pests.

Tree Improvement and the Importance of Seed Orchards

The science of tree improvement is relatively young, however it has had significant impact on the forest industry. For many species, both in the United States and around the world, tree improvement became an important aspect of forestry in the 1950s. Increasingly, any type of afforestation or reforestation effort relies on genetically improved stock. For example, in the southern US, over 90% of pine plantations are established with improved material.

Genetic improvement of any crop, including trees, relies on *selection* from a base population, *genetic testing* of the selections to confirm their superiority, and *breeding* to generate a new base population; this is then followed by another cycle of selection, testing and breeding. Thus, genetic improvement is a continuous process, with better material available after each cycle. Most tree improvement programs began with mass selection (identification of superior phenotypes) in native stands or plantations, followed by grafting of these selections into production seed orchards. After genetic testing, seed orchards were rogued or thinned, and clones proven to be poor performers were removed. The genetic gains achieved in most operational tree improvement programs have been substantial; for example, for growth traits, gains are on the order of 7 to 15% from mass selection, and 10 to 20% following roguing. Additional genetic gains have been made in other traits: stem form, wood quality and disease resistance. New advanced-generation orchards (established after additional testing, breeding and selection) are either currently producing or will be producing seed by the year 2005; these orchards will yield even higher genetic gains.

The economic value of these levels of genetic gain applied across the thousands of acres regenerated each year is truly staggering, with NPV of additional wood production due to genetic improvement equal to tens and perhaps hundreds of millions of dollars every year[3]. Realization of this value depends on the production of genetically improved seed for reforestation; this is the function of the seed orchard. Various cone and seed insects can devastate an orchard seed crop, thus, most organizations control insects through aerial spraying of chemical insecticides. **Without a comprehensive insect control program, losses of 50% of the orchard crop are common, and losses of 90% have been documented.** The information and technology needed for the effective control programs currently in use were developed through the combined efforts of forest industry, state forestry agencies and Forest Service scientists. Acreages of advanced-generation orchards (producing seed of the highest genetic quality) have been established assuming that effective insect control programs will be in place.

Today, however, there is growing concern among the public, and consequently governmental agencies over various environmental issues. For example, the Environmental Protection Agency (EPA) is searching for opportunities to curtail or minimize pesticide usage, hence we may lose registration of some of the most effective chemicals currently used in operational orchards. Current federal requirements make it extremely difficult to obtain (or even maintain) pesticide registrations, and thus it often requires a coalition of interested parties to provide the necessary research data. In addition, there is increasing

desire for more than just efficacy in our insect control programs. The desire is for safer and more environmentally-friendly insect control programs that will still provide the level of control needed to protect valuable seed orchard crops. These programs may include new insecticides, reduced rates of current insecticides, and some type of biological control, all combined into an integrated pest management strategy. We believe that the Forest Service should play an important role in the critical research and development necessary to design and implement these new control programs.

The Mission of the Forest Service

It is the responsibility of the USDA Forest Service to provide overall leadership in forest and forest-range conservation, development and use. This includes the development of policies and programs needed to keep the Nation's private and public lands fully productive[4]. Our forests produce an array of natural resources, including recreation, water, wilderness, wildlife, and wood. The needs of the Nation for these natural resources, particularly wood, cannot be accomplished only on federally-owned forest lands. In fact, Congress has found that

> *"most of the productive forest land of the United States is in private, State, and local governmental ownership, and the capacity of the United States to produce renewable forest resources is significantly dependent on such lands".*[5]

As regards forest pests, Congress found that

> *"insects and diseases affecting trees occur and sometimes create emergency conditions on all land, whether Federal or non-Federal, and efforts to prevent and control such insects and diseases often require coordinated action by both Federal and non-Federal land managers".*[6]

The interaction between the Forest Service and non-federal forest land managers is primarily the responsibility of State and Private Forestry, and protection from insect and disease is the responsibility of Forest Health. One of the activities proscribed by Congress for Forest Health is to

> *"determine the biological, chemical, and mechanical measures necessary to prevent, retard, control, or suppress incipient, potential, threatening, or emergency insect infestations and disease conditions affecting trees".*[7]

One objective of the Forest Service mission is *developing and providing scientific and technical knowledge improving our capability to protect, manage and use forests and rangelands.*[8] In the past, this objective has been admirably achieved in the area of seed orchard pest management. Forest Service entomologists have played a major role in determining the biology, life cycle and control of cone and seed insects, particularly in the South. Important basic and applied results have been determined by Forest Health and the Forest Experiment Stations through cooperative studies involving universities, state forestry agencies and forest industry. For example, Forest Service personnel and funds have been instrumental in the following critical areas:

- evaluating monitoring techniques for assessing insect populations and damage,
- developing techniques for aerial application of insecticides in seed orchards,
- designing and conducting field tests of promising insecticides (e.g., carbofuran, azinphosmethyl, fenvalerate, esfenvalerate, malathion, acephate, and bifenthrin),
- conducting field tests of the biological control organism *Bacillus thuringiensis* (Bt),
- developing and evaluating the Southwide Coneworm Pheromone Monitoring System,
- designing and implementing strategies for mating disruption of the webbing coneworm, and
- designing and conducting research to fill data gaps in order to maintain registration of several important seed orchard insecticides.

The past cooperation between Forest Service scientists and their state and private clientele in the area of seed orchard pest management is a tremendous success story. The current needs in this area are more pressing and the necessary research more complex than in the past, thus every effort should be made to ensure that this fruitful association continues in the future.

Research Needs in Seed Orchard Pest Management

The need for increased timber productivity on less land, along with increased pressure to modify the current patterns of pesticide usage make this a critical time for forestry and forest tree improvement. In the area of seed orchard pest management, a substantial research and technology development effort is essential. **Historically, the Forest Service has provided leadership in this research area. We believe it is critical that the Forest Service continues to do so in the future.** Private industry is very willing to cooperate with Forest Service scientists in conducting necessary projects to develop and implement orchard pest management programs, and can contribute substantial "in-kind" support: labor, land, money for application of experimental control programs in their orchards, experimental measurements, etc. However, the expertise of Forest Service specialists has been crucial in the past, and will continue to be extremely important in the future if long-term production requirements are to be met.

The SOPMS developed a survey in March 1994 to prioritize a number of research topics. The survey was distributed primarily to orchard managers in both the southern and the western US. For the southern states (VA, TN, NC, SC, GA, FL, AL, MS, LA, AR, OK, TX), surveys were distributed to both state agencies and private industries; for the western states (OR, WA, CA, ID, MT), surveys also went to various National Forests. Respondents were asked to rank six subject areas in order of priority:

- **Insect Biology**
  to gain a better understanding of life cycles, migration patterns, and other aspects of insect biology to enhance control and Integrated Pest Management strategies.
- **Alternative Insecticides**
  to examine efficacy of new insecticides, focusing on "environmentally friendly" products.
- **Evaluation of Current Insecticides**
  to test options of reducing amount of current products applied by a) extending application intervals, b) reduction of application rates, c) improving application techniques.
- **Population Monitoring**
  to develop reliable techniques of identifying optimum time of insecticide treatment.
- **Pheromone Development**
  to identify important reproductive pheromones and refine techniques such as mating disruption to control insect populations.
- **Biological Control**
  to investigate natural enemies of cone and seed insects, and effects of insecticides and cultural practices on these enemies.

A total of 77 responses were received (36 in the south, 41 in the west). The results of the survey are summarized for the two regions in Figure 1. In both regions the development of **Alternative Insecticides** was highly ranked (1st in the south, a close 2nd in the west). This may reflect a widespread perception of imminent loss of registration of current insecticides. Without alternative products, such a loss would be a severe blow to our efforts to increase productivity through genetic improvement. **Insect Biology** was ranked 1st in the west, perhaps reflecting the need for basic information on a wider range of tree species and their insect pests in the west as opposed to the south.

Conclusions

The Forest Service has a legislative mandate to provide leadership in keeping the Nation's public and private forest lands fully productive. The demand for wood products in the US will continue to grow, and the decreased harvest of wood from federal lands means that there is increased pressure on state and private lands to be more productive. We believe that the Forest Service has a responsibility *to develop and provide the scientific and technical knowledge* to make this increased productivity possible. Tree improvement can play an important role in increasing the productivity of state and private lands dedicated to timber production. Forest Service scientists are needed to ensure that the genetically improved material for reforestation can be efficiently produced. Seed orchard pest management is economically and environmentally important, and should receive strong support.

Endnotes

[1]Highlights, Report of the Forest Service, Fiscal Year 1993. 1994. USDA Forest Service, Washington DC.

[2]Gary Lettman, Forest Economist, Oregon Department of Forestry, personal communication.

[3]To illustrate, consider the following information for the South US, where approximately 1 million acres per year are established in pine plantation. Assume 1.5 cords/acre/year, a 25 year rotation, $40/cord stumpage value, 15% genetic gain, and a real interest rate of 5%. Then the NPV of additional wood due to genetic improvement from one years harvest equals $66 million. Since genetic gain is permanent, this marginal gain can be realized every year, as long as improved material is planted.

[4]Code of Federal Regulations, Title 36. 1994.

[5]Forest Stewardship Act of 1990.

[6]Ibid.

[7]Ibid.

[8]US Government Manual. 1994.

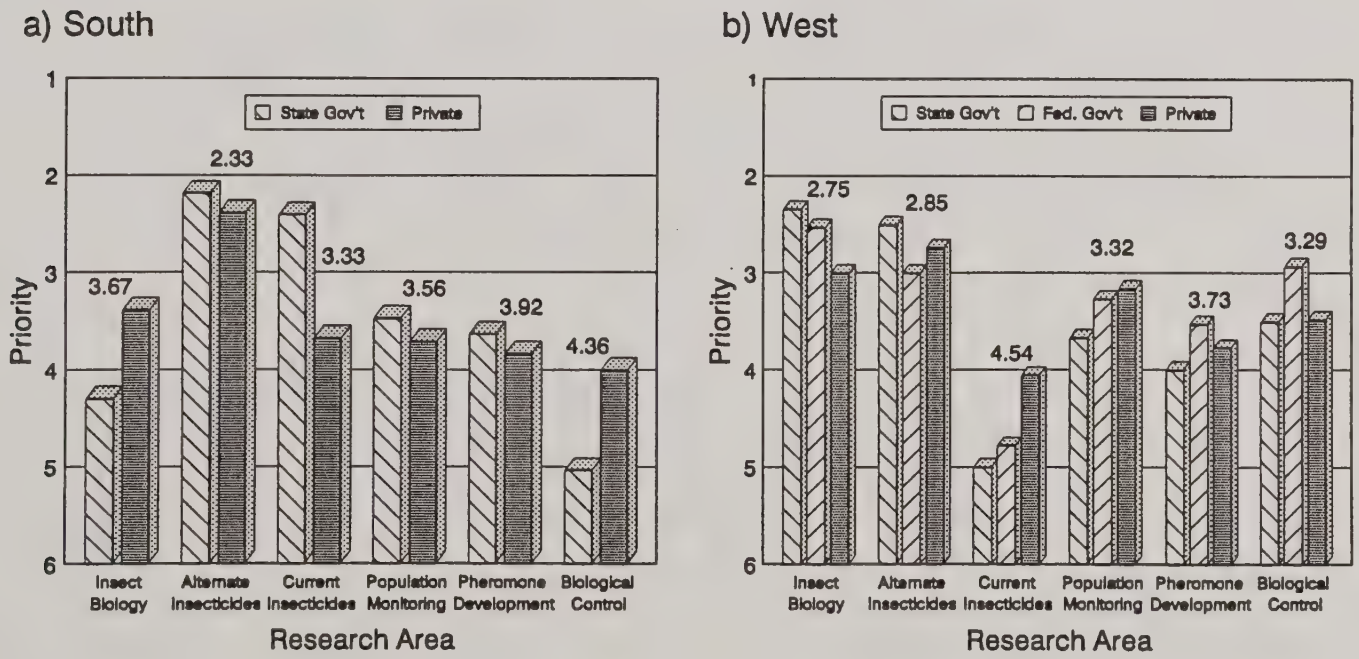

Figure 1. Average priority assigned to research areas in seed orchard pest management for the southern (1a) and western (1b) United States. Survey respondents were primarily seed orchard managers. Number of respondents was 87 (SOUTH: State=12, Private=24; WEST: State=6, Federal=14, Private=21).

Memo

TO: USDA Forest Service Administrators:
Forest Management, Research, and Forest Health-
State and Private Forestry

FROM: Dr. Floyd Bridgwater, Chairman
Southern Forest Tree Improvement Committee (SFTIC)

Date: June 28, 1995

SUBJECT: **A Position Paper on the Role of The USDA Forest Service in Seed Orchard Pest Management Research and Development**

The Southern Forest Tree Improvement Committee has been an active voice for tree improvement in the southern United States for more than 45 years. The Committee has broad representation of scientific leaders and tree improvement practitioners from forest industry, state agencies, universities, tree improvement cooperatives, and government. A current membership list of SFTIC is attached for your information.

During the past year a SFTIC subcommittee has developed a Position Paper on "The Role of the USDA Forest Service in Seed Orchard Pest Management Research & Development". The paper has been unanimously approved by the Southern Forest Tree Improvement Committee and endorsed by: The Inland Empire Tree Improvement Cooperative and the Northwest Tree Improvement Cooperative. This paper presents our views on how the Forest Service should be involved in research, technology development, and technology transfer in seed orchard pest management.

We believe, as do our colleagues in the western regions of the country, that the USDA-Forest Service should strengthen their support of pest management research and development work related to seed orchards. We further believe that this support is critical to the future productivity of our nations forests. We hope that you agree with our position and that upon review of the attached paper, you will suggest ways that we could work with you to secure the needed support.

Thank you for your consideration.

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(919) 515-2891

FAX # (919) 515-7231

Memo

TO: **Seed Orchard Pest Management Sub-Committee and Floyd Bridgwater, Chairman of SFTIC**

FROM: Bob Weir, Chairman SOPMSC

Date: June 30, 1995

SUBJECT: Seed Orchard Pest Management R & D White Paper for USFS

FINALLY!!! Today "The White Paper" was mailed to 56 people in the USFS. The enclosed packet of memos, letters, endorsements, etc were sent to each person.

The people receiving it were essentially all the Research, Timber Management, and S & PF Administrators, Directors, genetics and insect specialists, etc. in Washington and in each timber management region and each Research Station except where there were obviously no seed orchard or pest management activities (now or in the past).

Next week I will distribute this to the State Foresters and the insect / disease specialists in each of the states.

Cheers!!

United States Department of Agriculture | Forest Service | Washington Office | 14th & Independence SW
P.O. Box 96090
Washington, DC 20090-6090
(202) 205-1600

Reply to: 3400

Date: September 21, 1995

Dr. Floyd Bridgwater
Chairman
Southern Forest Tree Improvement Committee
Southern Forest Experiment Station
Post Office Box 12254
Research Triangle Park, North Carolina 27709

Dear Dr. Bridgwater:

I am writing in response to your Committee's Position Paper on "The Role of the USDA Forest Service in Seed Orchard Pest Management Research and Development."

My staff has a long record of strong support for integrated pest management, including work that addresses your area of interest. The following are some examples:

We sponsor the National Seed and Cone Steering Committee that meets annually to share technology and propose priority needs for new technology.

Through our Technology Development Program we annually sponsor projects that our Regions propose to develop protection technology. In fiscal year 1995, for example, we are sponsoring projects on development of alternatives to methyl bromide, and on improving seed production in longleaf pine seed orchards.

We sponsor the Resistance Screening Center at Bent Creek, North Carolina, which has for many years screened seed from private and Federal seed orchards across the South for resistance to fusiform rust.

Through the National Agricultural Pesticide Impact Assessment Program (NAPIAP) we annually sponsor projects to gather data necessary to retain registration for pesticides used in forestry. For example in fiscal year 1995 we are sponsoring projects on root rot in nurseries.

Through the years we have sponsored risk assessments for pesticides used in seed orchards and nurseries, and recently awarded a new multi-year contract for additional risk assessments.

Our staffs in the Southern and other Regions provide technical assistance to Federal seed orchard and nursery managers and assist the States in providing assistance to private individuals and nurseries. In the South, for example, our Staff has 4 specialists who work full time on seed orchard problems and 3 specialists who work full or part time on nursery problems.

In conclusion, I am proud of the leadership and work of my staff in this important area and the strong collaboration that exists with you and your colleagues. I encourage you to continue to work with our Regional Forest Pest Management staffs to help ensure that the priority protection needs for tree improvement programs are met.

Sincerely,

/s/ ANN M. BARTUSKA
ANN M. BARTUSKA
Director, Forest Pest Management

cc:
Director, WO, FIDR (with copy of the incoming letter)
Director, WO, CF (with copy of the incoming letter)
Richard Fowler, WO, FPM

FPM:R.Fowler:lt:09/20/95:205-1600

United States Department of Agriculture | Forest Service | FHTET - Davis Washington Office | 2121 C Second Street
Davis, CA 95616
PH (916) 757-8341
FAX (916) 757-8383

File Code: 3400

Date: September 27, 1995

James C. Space
USDA Forest Service
Director, Pacific Southwest Forest
and Range Experiment Station
P.O. Box 245
Berkeley, CA 94701

Dear Jim:

I do not believe we will meet the expectations, needs, and demands of our stakeholders by reducing our seed, cone, and regeneration insect research to that of a single and underfunded project at the Southern Research Station (SO).

Our stakeholders in the public and private sectors look to the USDA Forest Service (Forest Service) for national and international leadership in conducting and coordinating seed, cone, and regeneration insect research. They also look to the Forest Service as partners in transfer and implementation of research findings and technologies to support healthy, diverse, and productive forests. Basic and applied research are essential to these objectives. It appears that the need for seed, cone, and regeneration research has become sidelined in our thrust toward ecosystem management approaches while in fact there has never been a greater need for this research. I believe most of us realize that the slack in demand for genetically improved, disease resistant, and genetically mixed, natural seed by our Forest Service land managers is only temporary. All types of seed will be needed to meet both current and future demands for timber, forest health, and biodiversity on federal lands. The need for seed and seelings to meet non-Federal plantings essentially remains uninterrupted and growing.

I realize that tough decisions must be made in light of continuing budget reductions. Such crises, however, provide opportunities for enterprising approaches which could produce a strong, responsive, and combined east and west seed, cone, and regeneration insect program. An initial approach could be to combine the Pacific Southwest Forest and Range Experiment Station (PSW) and SO seed, cone, and regeneration insect research, with the researchers remaining at their current locations and continuing work in their respective geographical work areas. Concurrently form a task group that represents Forest Service

stakeholders (S&PF, NFS and Research) and stakeholders from industry, States, and academia to develop a strategic approach that would lead to a coordinated and cooperative seed, cone and regeneration insect research program involving active support and participation of stakeholders. Various working groups and committees are in place outside the Forest Service, but there is lack of national level support, leadership and coordination. Also I believe the perception exists that the Forest Service should be funding most if not all of this research. Others should be invited to make direct and indirect financial contributions. To make this happen we need an enterprising Forest Service leader to step forward and coordinate a cooperative and resource sharing approach with our stakeholders both within and outside the Forest Service. Meanwhile my hope is for retention of the seed and cone research unit at PSW while the enterprising approach is being developed.

Sincerely,

John W. Barry
Director, FHTET-Davis

North Carolina State University

Department of Forestry
College of Forest Resources

Box 8002
Raleigh, NC 27695-8002
(919) 515-2891

FAX # (919) 515-7231

November 6, 1995

Dr. John W. Barry
Pesticide Specialist , Aerial Application
USDA Forest Service
2121-C Second Street
Davis, California 95616

Dear Dr. Barry:

The Seed Orchard Pest Management Subcommittee of the Southern Forest Tree Improvement Committee developed a position paper recommending that the USDA-Forest Service refocus and strengthen their research and development work with respect to cone and seed insect control in seed orchards. This paper, endorsed by the Pacific Northwest Tree Improvement Cooperative and the Inland Empire Tree Improvement Program, was distributed to you in early summer. We have been asked by several persons in the USFS to suggest a specific response by the Forest Service that would meet the apparent needs as described in the position paper.

The subcommittee met recently to develop our recommendations pertaining to the minimum resource requirements that we believe should be committed by the USFS to the control of cone and seed insects in seed orchards. As chairmen of the Subcommittee, I have been asked to contact you with our recommendations.

The USDA-Forest Service has significantly decreased emphasis in production forestry. As a result there is increased pressure on state and private lands to increase production. The Forest Service has a legislative mandate to provide leadership in keeping the Nation's public ***and private*** lands fully productive and to develop the scientific and technical knowledge needed to make this increased productivity possible. Tree Improvement is a key strategy, and the protection of orchard seed crops is essential if tree improvement gains are to be realized through highly productive plantations. Forest Service contributions in this area have been indispensable in the past and future support is critical to the productivity of our nations state and private forests.

We believe the minimum resources needed to maintain or in some cases reinstate effective R & D programs are as described in Table 1. These dollars are incremental to existing resources. No doubt some reassignment of capable entomology scientists and support personnel could occur in lieu of incremental dollars. There is a major concern about the loss of existing pesticide control systems, and the need to quickly pursue integrated pest management approaches. The incremental dollars we have recommended do not get us where we need to be soon enough, but are believed to be appropriate in consideration of the need to control government spending. The specific locations of resources are not specified in our recommendations and would be open to discussion with the Forest Service leadership.

Table 1. Recommended incremental dollar support for cone and seed insect research and development work in seed orchards. Research dollars would be for scientists, technicians and operating money within Forest Research Stations, and Development dollars are specified for technicians and operating dollars for Forest Health Cone and Seed Insect Specialists, State and Private Forestry.

Research	**Region**	**Staff & Support**	**$ (Annual)**
	West	2 - GS 14-7	$ 184,322
		2 - GS 5-7	64,438
		Support	60,000
	South	Reassignment of one existing entomologist	- - - - - -
		Support	60,000
			$ 368,760
Forest Health (State & Private)	Region 1	1 - GS 5-7	32,219
		Support	30,000
	Region 6	1 - GS 5-7	32,219
		Support	30,000
	Region 8	Support	40,000
			$ 164,438
		Total Dollars	**$ 533,198**

We hope that as budget planning proceeds for the next federal fiscal year, provisions can be made for support of this vital scientific area in accordance with our recommendations. We are also reviewing this issue with the National Association of State Foresters, the American Forest and Paper Association, and several key legislators. Should you have questions I would be most happy to discuss these recommendations with you.

Sincerely,

Robert J. Weir

Dr. Robert J. Weir, Director
Cooperative Tree Improvement Program
and
Chairman, Seed Orchard Pest Management
Subcommittee

cc's: Floyd Bridgwater, Chairman Southern Forest
Tree Improvement Committee

Members Southern Seed Orchard Pest Committee

Appendix E

Sub-committee Report and Suggested Changes
to 5-Year Plan

I have made suggestions, **in bold**, to update this plan

5-YEAR TACTICAL PLAN

National Steering Committee for Managing Insects of seeds, cones and young plantings

August 1993

CONTENTS

I. INTRODUCTION

Purpose

The purpose of this 5-Year Tactical Plan (Plan) is to support the Forest Health Management(FHM) Technology Development process by establishing a system of identifying seed, cone, and regeneration insect goals and actions that support Forest Health Management's strategic direction and goals to protect the health of America's forests (1). The scope of the plan is primarily limited to managing seed, cone, and regeneration insects and the FHM Technology Development Program. Basic research, however, cannot be separated and for this reason research as essential to accomplishing the goals is included. In this context the Plan, therefore, becomes a rational, logical, and sequential system to achieve stated goals. It provides management a roadmap and an instrument to monitor progress.

Background

The evolution of the FHM Technology Development Program is one of continued effort to improve its process, efficiency, productivity, and accountability. Prior to establishing national steering committees in 1988 the process of managing the technology development, or special projects, was generally undefined, focused on the near-term, lacked prudent accountability and was not tied to strategic goals. Given those shortcomings the program was productive but clearly there was the need for improvement. Each year since 1988 the FHM Technology Development Program has been improved to address its new needs and opportunities. Suggestions and support from field units, the FHM National Steering Committees, and availability of a WO Staff Scientist to manage the Program have contributed to an effective FHM Technology Development Program.

The National Steering Committee for Managing Seed, Cone, and Regeneration Insects and the other FHM National Steering Committees, were asked in 1993 by the Director, FHM, to prepare 5-Year Tactical Plans. The plans are to specify short-term needs within a 5-Year span that are of high priority and consistent with strategic forest health planning. The relationship of national steering committee tactical forest health and ecosystem management planning is outlined on the enclosed figure (not available on DG

version). The figure clearly identifies the role and relationship of the steering committee in support of forest health and ecosystem management.

At the 1993 Placerville meeting the committee identified 20 needs (2). Of these 20 the 7 most important, determined by vote, were discussed. The committee then ranked the 7, again by vote, and the 7 needs were then stated as goals and listed herein by order of priority. **I SUGGEST WE REVIEW THIS PROCESS AND IF WE CAN SUGGEST ANOTHER PROCESS TO USE THE NEXT TIME THESE DECISIONS ARE MADE**

Figure

Relationship of WO/FHM National Steering Committee Tactical Planning to Forest Health and Ecosystem Management Planning **WE NEED TO UPDATE THIS TO REFLECT CHANGES BECAUSE OF ENTERPRISE TEAM**

(Not available on DG version)

Program Categories

This committee identified 6 administrative program categories that cover all proposed activities within the 5-Year Tactical Plan. If the need does not fit one of these categories, it is likely beyond the scope of this committee and its plan. The categories are:

- Basic biological and taxonomical information
- Impact
- Monitoring
- IPM situation/decision models **[Links to Planning (Decision Support Systems)]**
- Control strategies

  Management Activities to Address Pest Concerns

  Effects of Management on non-target organisms
- Technology transfer and training

Within these categories, activities would include basic research, applied research, development, demonstrations, operations, and technology transfer. FHM cannot by law provide funds to support basic research, but should coordinate needs with researchers and form partnerships to address research needs that affect tactical planning goals.

Format of Plan

We have chosen a format that does not include a vision or mission statement to be consistent with the Chief's direction of one Forest Service vision and mission statement. Each Goal statement is followed by a Rationale that clarifies and expands upon the goal statement, explains why this goal is important, and discusses how it relates to forest health and ecosystems management. This is followed by Actions to accomplish the goal. In case there is need for sub-actions, we can refer to these as Strategies in future updates of the plan. Each Action and Strategy will be assigned a date for completion with a 5-year to 7-year span as the plan is expanded. Specific years have been assigned to some of the goals while others are assigned by Phase and/or Year-1 as an example. Initiation of action items under some goals is dependent upon insect populations. **SHOULD WE HAVE A SECTION TO INDICATE ACCOMPLISHMENTS?**

II. 5-YEAR TACTICAL PLAN

A. Cone and Seed Insects

Goal 1 - White Bark Pine

Regeneration insects of white bark pine have been identified, monitoring and impact assessment methods developed, and potential control strategies have been identified.

Rationale

Only recently has white bark pine, Pinus albicaulis, been recognized as a key component of high elevation ecosystems throughout much of the West. This unique species plays an important role in the survival and distribution of such wildlife species as the grizzly bear and the Clarks nutcracker, by providing a high protein food source with its cones and seeds. Research has recently documented the rapid decline of this important species in western Montana and other areas (Keane and Arno, 1993) due primarily to the introduced white pine blister rust fungus and periodic outbreaks of the mountain pine beetle. A need is being recognized to promote natural regeneration and to supplement it artificially, especially with rust resistant nursery stock.

To date virtually nothing is known about the role cone and seed feeding insects play on the regeneration of this species. Prior to developing treatments to protect cones and seeds from insect depredations, it has to be determined what insect complex is affecting seed production, the extent of its impact, and whether protection is needed.

This technology development project would be a cooperative effort with R-1 FHM, R-1 Genetic Resource Program, and the PSW Station.

Actions

It is proposed that this goal be addressed in three phases with the initial phase beginning when there is a sufficient flower crop.

Phase 1

Years 1-3

Initial work to be done on this Goal will be to determine the insects that are significantly affecting white bark pine seed production, and the impacts they're having. This will be accomplished by locating cone collection sites in representative stands and collecting cones to obtain insect specimens through cone dissections and rearing. Insects thus obtained will be sent to specialists for positive identification. The type and extent of damage caused by each pest will be measured. To ensure an accurate assessment, and to capture all important insects species involved, this phase of the project will continue for three years. Due to the sporadic cone production of most conifer species, these likely will not be three consecutive years. With this background information in hand the need for population monitoring and subsequent control tools can be assessed.

Phase 2

Year 4-5

Assuming the pest identification/impact assessment phase of this project verifies a need to control insects affecting white bark pine cone and seed production, effort will be directed towards identifying how to recognize when populations exist that, when left untreated, will cause untolerable impacts. Monitoring tools may include such approaches as pheromone baited traps, sample cone dissections, light traps, beating samples, etc.

Phase 3

Year 5-7

The final phase of this project will be the development of control approaches. Alternatives include the application of microbial and/or chemical insecticides, pheromones for mass trapping and/or mating disruption, and mechanical and/or cultural control approaches.

Contact Scientist
Jed Dewey
R-1/FHM
J.Dewey:R01A
(406) 329-3637

Goal 2 - IPM for Southeastern Coneworms

Integrated Pest Management strategies for southeastern coneworms have been developed.

Rationale

Coneworms are considered to be the most potentially damaging insect species attacking southern yellow pine seed orchards. A pest management system is needed to tie together three decades of research and development concerning the survey, detection, evaluation, and control of coneworms. Development of an Intergrated Pest Control System to minimize the impact coneworm populations on all southern pine seed orchards is needed now. The following steps will guide us in this project:

Actions

1994 Develop the computer system to collect weather and pheromone trap catch data. We will develop the protocol to evaluate current pheromone trap catch data and compare it to the historical data collected the past 12 years.

1995 Degree day models for 2 of the coneworm species will be integrated into the computer system in 1995 and the models will be field tested and validated. The computer system will be further developed to handle communications between orchard managers and project entomologists on key sites across the South.

1996 In 1996 the remaining 2 Degree Day models for the other coneworm species will be field tested and added to the computer IPM system. Computer based warnings of impending pest outbreaks will be integrated into the data system allowing the analysis of pest populations as they develop in the spring and summer.

1997 By 1997 the IPM system will be operational, collecting weather and insect population and communicating to cooperating orchards meaningful information on potential pest threats, spray timing, and pest treatment recommendations. Additional evaluation and tuning of the model will be required.

Contact Scientist

Larry Barber
R-8/FHM
L.Barber:S29A

264 (704) 257-4320

Goal 3 - Dioryctria Pheromone Southeast

Pheromones for Dioryctria spp. has been developed and available for operational use in the southeast.

Rationale

During the past 3 years entomologists with FHM and SEFES have attempted to disrupt mating and to reduce damage using pheromones of Dioryctria disculsa and D. merkeli. Because larval damage occurs in the year after adult treatment, efficacy data is available for only 2 of the last 3 years of the disruption treatments. During the three year study we have successfully disrupted mating by shutting down of baited pheromone traps in the treatment blocks. We also were able to show disruption of live virgin females place in mating table in the treatment area in 1992. A very limited supply of females in 1991 and 1993 made it impossible to establish mating tables and to test mating disruption during these years using this method of evaluation. In the future we intend to further evaluate mating disruption using pheromones as an alternative to toxic insecticides such as Guthion. The following is the outline for further work in this area.

Actions

1994 In 1994 we will determine damage from D. disclusa and D. merkeli on 2 southern pine seed orchards treated with pheromone in 1993. Following preliminary testing, application in the treatment blocks will be pheromone flakes, applied with aircraft.

1995 In 1995 we will determine the damage from D. disclusa and D. merkeli in the treatment plots following aerial application the previous year. We will also retreat the treatment blocks during the spring and summer of 1995 using aircraft.

1996 In 1996 we will evaluate the previous treatments and if the results are favorable from the previous two years we propose expanding the evaluation to the remaining two conewrorm species ie. D. amatella, and D. clarioralis in 1996 and 1997.

1997 Continue work with other Diorytria spp.

1998 Reporting and technology transfer activities.

Contact Scientist

Larry Barber
R-8/FHM
L.Barber:S29A
(704) 257-4320

Goal 4 - Western White Pine

Monitoring and control systems for western white pine seed bug and coneworm have been developed and are available for use. Basic taxonomic issues are settled and behavioral chemicals for western white pine seed bug, cone beetle and coneworm have been identified and are available for development into pest management tactics.

Rationale

Reforestation of forests with western white pine depends upon seed with known levels of blister rust resistance from seed orchards. In order to restore white pine in areas where its presence has diminished by mortality due to blister rust and to replace root disease susceptible species in root disease pockets with a more root disease tolerant species, western white pine seed is in great demand and growing with emphasis on ecosystem management. The major pests, which can practically eliminate the cone crop, are seed bugs and (locally) cone beetles and coneworms. Basic research must be conducted to support the development of pest management options.

Actions

Western Cone Beetle

Years 1 - 3 Identify the components and the structural and stereochemical identities of the useful components.

Year 4 Determine trap or releasor design and useful release rates.

Year 5 Conduct initial field trials of trap-out or repellent strategies.

Year 6 Evaluate and report results.

Seed Bugs

Years 1 - 3 Identify the major marker pheromones.

Years 4 & 5 Conduct field trials to determine if marker pheromones are useful in monitoring for seed bugs.

Dioryctria

Years 1 - 3 Conduct taxonomic evaluations and life cycle/host plant relationship investigations.

Years 3 - 5 Continue investigations on identification of behavioral chemicals potentially useful for population monitoring or manipulation.

Contact Scientist
Roger Sandquist
R-6/FHM
R.Sandquist:R-6/PNW
(503) 326-6222

Goal 5 - Single Tree Treatment

Single tree treatment methods to control seed and cone loss in wild stands have been developed and demonstrated.

Rationale

Several conifer species, such as sugar pine, western white pine, and Port-Orford-cedar, are seriously threatened by introduced diseases that have had drastic effects on our ability to reforest these indigenous conifers. In the future, managed seed orchards will meet our seed requirements for these species. However, we currently depend on collection of seed from disease-resistant trees in wild stands. These trees are usually remote from other Forest Service activities and are very tall, so it is difficult to treat them using conventional methods. Furthermore, the disease-resistant pines are attacked by a cone beetle, Conophthorus ponderosae, that probably cannot be controlled with implanted systemic insecticides. Aerial application of insecticides to such trees, in addition to being controversial, is prohibitively expensive in today's budget climate. Early tests of an arboreal sprinkler system (coupled with a truck-mounted spray tank) appear to have promise as an effective, inexpensive, and semi-permanent system for protecting valuable cone crops in remote sites. The cost for such arboreal sprinklers may be as low as $25 per tree.

Actions

1993 Develop and test a single-nozzle prototype of the arboreal sprinkler system in sugar pine.

1994 Test a multiple-nozzle prototype and compare with single-nozzle system, using both seed yield and spray recovery as measures of treatment efficacy.

1995 Continue study to obtain two years of efficacy data to increase statistical database.

1996 Compare the best arboreal system with an aerial (helicopter) application of the same insecticide.

1997 Technology transfer

Contact Scientist

Nancy Rappaport

PSW Albany

N.Rappaport:S27A

407 (510) 559-6474

Goal 6 - Dioryctria Pheromone Douglas-fir

Effective pheromone detection systems for Dioryctria spp. in Douglas-fir have been demonstrated.

Rationale

The fir coneworm, Dioryctria abietivorella (Grote), has a wide host range in tree species as well as the issues attacked. The taxonomy of western Dioryctria spp. is in a state of confusion, and the pheromone that has been identified for Dioryctria abietivorella, a transcontinental species, does not reliably attract this species in the field. In fact, D. abietivorella as currently construed attacks a number of conifer species (Douglas-fir, true firs, and pines) and various tissues of those host species, including cones, buds, shoots, galls, wounds, and graft unions of Douglas-fir and other western conifers. Damage to cones of Douglas-fir and true firs can be severe in plantations and orchards. The development of an effective pheromone, and subsequently detection systems, is vital to the management of this insect in situations such as the Chico Tree Improvement Center. Accurate species characterization is absolutely essential for the development of pheromonally based insect control methods; mating disruption is a promising method for controlling Dioryctria spp., but both the insect species and their behavioral chemicals must be accurately identified. It has been suggested that D. abietivorella represents more than one species, but systematists have been unable to resolve this question with classical morphological methods. New methods based on pheromones and amplified DNA techniques, however, may provide quick and reliable species separation in this problematic group. The most effective research and development approach for dealing with this type of problem is to combine R&D on behavioral chemicals with development of quick genetic or biochemical assays for species identification. Such an approach is based on simultaneous sampling of pheromones, cuticular hydrocarbons, isozymes, and DNA (ribosomal or mitochondrial), so that clear links can be established between pheromones and taxonomic criteria at the same time that effective behavioral chemicals are identified and validated.

Actions

1994 Collect specimens of D. abietivorella and sample their cuticular hydrocarbons, pheromones, host volatiles, and mtDNA/rbDNA.

1995 Continue 1994 effort, and assay potential behavioral chemicals using laboratory olfactometers and electroantennograms.

1996 Field-test behavioral chemicals that were identified in laboratory assays, and develop optimum releasers and release rates for both monitoring (traps) and control (mating disruption releasers).

1997 Correlate pheromone trap catches with damage rates in seed orchards, and conduct preliminary field-test of mating disruption techniques.

1998 Conduct full-scale field test of mating disruption and validate monitoring and damage prediction using baited traps.

Contact Scientist
Nancy Rappaport
PSW Albany
N.Rappaport:S27A
(510) 559-6474

Goal 7 - IPM for Southeastern Seedbugs

An Integrated Pest Management system for managing southeastern seedbugs has been developed, evaluated, and is operational. (Larry Barber)

Rationale

Seedbugs, Leptoglossus corculus and Tetyra bipuncta are the most underrated pest in southern pine seed orchards and an Integrated Pest Management system for reducing damage and pesticide usage is needed. Also, any IPM system that controls coneworms using pheromones or Bacillus thuringiensis needs to also control seedbugs with pesticides. Field studies have shown that seedbugs can be controlled with small amounts of pesticides as compared to current application rates for coneworms. We believe that two correctly timed application of a pesticide such as Asana XL would be sufficient to control seedbugs if properly applied at the correct time. Currently we apply up to 5 applications at full strength to control seed and cone insects. There is significant potential to reduce amounts of chemical pesticides and thus reduce environmental insult.

Actions

1994 In 1994 we will field test and validate the degree day models that are now being developed by SEFES entomologists.

1995 Continue field testing and validation.

1996 In 1995 and 1996 we will use the degree day models to time insecticide sprays. This testing will take at least two or three growing seasons. After testing and validation of the spray timing model for pesticide application it will be used in conjunction with coneworm pheromone application.

1997 Continue field testing.

1998 Continue field testing.

1999 Reporting and technology transfer.

Contact Scientist

Larry Barber
R-8/FHM
L.Barber:S29A
(704) 257-4320

B. Insects of young plantings

REFERENCES

1. USDA Forest Service. 1993. Healthy Forest for America's Future - A Strategic Plan. US Department of Agriculture, Forest Service, Washington, DC.
2. USDA Forest Service. 1993. Fifth Report National Steering Committee for Management of Seed, Cone, and Regeneration Insects, FHM 93-13. Forest Health Management, Davis, CA.
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